

## **Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.



Reserve  
aTK9152  
.U5  
1975

*New  
NS*

*Refer ARS*

# **RADIOLOGICAL SAFETY HANDBOOK**



UNITED STATES DEPARTMENT OF AGRICULTURE  
AGRICULTURAL RESEARCH SERVICE

AD-33 Bookplate  
(1-63)

**NATIONAL**

**A  
G  
R  
I  
C  
U  
L  
T  
U  
R  
A  
L**



**LIBRARY**

## PREFACE

This "Radiological Safety Handbook," hereinafter called the handbook, is the official instruction on matters relating to radiation safety and control for all agencies of the U.S. Department of Agriculture (USDA), hereinafter called the Department. It has been prepared by direction of the Department's Radiological Safety Committee, hereinafter called the Committee, that serves as the advisory body to the Administrator, Agricultural Research Service (ARS), and to employees of all agencies of the Department on the total problem of radiation protection and control. The Committee members are appointed by the Administrator, ARS, pursuant to Title 1, Administrative Regulation 376-386.2, and have responsibility for safeguarding personnel, property, and the community at large from the potential hazards of radiation from all possible sources and thereby minimize legal risks associated with the presence or use of ionizing radiation.

To perform the duties necessary to implement the Department's program of radiation protection and control, the Committee has arranged for the appointment of a Department Radiological Safety Officer (RSO) and has delegated to him authority for maintaining the program on a day-to-day basis (see Appendix A, p. 25). The RSO and his Radiological Safety Staff (RSS) have available, however, the entire membership of the Committee to assist in the resolution of any special problems that may arise. Since the individual members of the Committee possess a diverse background in scientific and administrative skills, their attention to the resolution of special problems can effect a satisfactory result in minimum time.

The Department has applied for and has been granted licenses by the U.S. Nuclear Regulatory Commission (USNRC) for the possession and use of radioactive materials and/or certain radiation-emanating equipment by qualified personnel throughout the Department. A part of the application for these licenses was this handbook, which sets forth the rules and requirements to be employed by the Department to control the possession and safe use of radioactive materials and/or radiation-emanating equipment. Consequently, these rules and regulations are an integral part of the total responsibility of the Department to conform to the terms and conditions of its licenses. It is incumbent, therefore, upon every prospective or Committee-authorized user of radioactive materials and/or radiation-emanating equipment to observe the rules and regulations contained in this handbook and to effect all reporting requirements diligently and promptly. As used in this handbook, the verb "shall" denotes that the ensuing recommendation is necessary or essential to meet standards of protection, and "should" indicates advisory recommendations that are to be applied when practicable. It is the responsibility of supervisors and authorized users to see that all persons under their jurisdiction comply in full with the provisions of this handbook. Adherence to rules will minimize the probability of occurrence of incidents, exposure to excessive radiation, and items of noncompliance. Failure to respect the responsibilities locally places the licenses for the entire Department in jeopardy.

U. S. DEPT. OF AGRICULTURE  
NATIONAL AGRICULTURAL LIBRARY

MAY 18 1977

CATALOGING

As a Federal agency that uses radioactive materials and/or radiation-emanating equipment, the Department is subject only to the licensing and regulatory requirements of the USNRC and is thereby exempted from regulations imposed by an Agreement State (any State with which the USNRC has entered into an effective agreement under Subsection 274 B of the Atomic Energy Act of 1954, as amended) upon persons within its borders who manufacture, produce, receive, possess, use, or transfer byproduct materials, source, or special nuclear material in quantities not sufficient to form a critical mass. Any inquiries regarding these received by USDA employees from other Federal, State, or local agencies should be referred to the RSO, address below, for action. However, the absence from this handbook of any other applicable regulations of any Federal, State, or local agency does not relieve employees of the responsibility for complying with such regulations.

Because the conditions of use will change with time, it is expected that the rules and regulations will change correspondingly. For this reason the handbook is looseleaf to facilitate changing single pages or sections as required. A page-numbering system has been employed that will not disrupt the numbering scheme of the entire publication when supplementary material is added. The contents has been set up as an index to facilitate finding specific information.

This handbook supersedes all previous Committee memoranda that have been published prior to March 1975; such memoranda are therefore canceled. This handbook also supersedes the last one published on July 1, 1961.

Any matters not adequately explained here should be directed to Radiological Safety Staff, U.S. Department of Agriculture, Room 227, Building 001, Agricultural Research Center-West, Beltsville, Md. 20705. Telephone (301)344-3054.

**RADIOLOGICAL SAFETY COMMITTEE  
U.S. DEPARTMENT OF AGRICULTURE  
1975**

E. R. Goode, Jr., Chairman, OA, NPS, ARS  
P. C. Kearney, AEQI, ARS  
S. L. Krugman, TMR, FS  
H. M. Kunishi, AEQI, ARS  
M. T. Ouye, OA, PACS, ARS

W. Mertz, NI, ARS  
D. Williams, VS, APHIS  
F. J. Longen, OA, ARS  
C. Z. Kwast, OA, RSS, ARS  
H. Roberts, Jr., OA, RSS, ARS



# CONTENTS

Sections 1.0 - 11.0

Page

Section	1.0	Definitions of Pertinent Terms Used in This Handbook .....	1
	1.1	Radioactive Material .....	1
	1.2	Radiation-Emanating Equipment .....	1
	1.3	Prospective User .....	1
	1.4	Authorized User .....	1
	1.5	10-CFR-20 .....	1
	1.6	Radiation Protection Officer .....	1
	1.7	Radioactive Contamination .....	1
	1.8	Background Radiation .....	1
	1.9	Sealed Source .....	1
	1.10	Ionizing Radiation .....	1
Section	2.0	Rules and Requirements Concerning Approval for Radioactive Materials and/or Radiation-Emanating Equipment .....	1
	2.1	Acquisition .....	1
	2.2	Use .....	2
	2.3	Transfer of Materials or Equipment .....	2
	2.4	Cooperative Work Projects .....	2
	2.5	Research in Non-USDA Facilities .....	2
	2.6	Request for Approval .....	2
	2.7	Followup .....	3
	2.8	Notice of Action .....	3
	2.9	Purchase Procedure .....	3
	2.10	Modification of Research Proposal .....	3
Section	3.0	Rules and Requirements Concerning Receipt, Use, and Disposal of Radioactive Materials and/or Radiation-Emanating Equipment .....	3
	3.1	Receipt of Materials .....	3
	3.2	Use of Materials or Equipment .....	3
	3.3	Special Reports .....	3
	3.4	Radioactive Waste Disposal .....	3
	3.4.1	Radioactive Waste-Disposal Records .....	4
	3.4.2	Radioactive Waste Preparation .....	4
	3.4.3	Radioactive Waste Storage .....	4
	3.4.4	Disposal of Short Half-Life Radioactive Waste .....	4
	3.4.5	Disposal by Release Into Sanitary Sewerage System .....	4
	3.4.6	Disposal by Burial .....	5
	3.4.7	Disposal by Incineration .....	5
	3.4.8	Disposal by Transfer to Authorized Recipient .....	5
	3.5	Inventory Records .....	5
Section	4.0	Rules and Requirements Concerning Personnel .....	5
	4.1	General .....	5
	4.2	Maximum Permissible Exposure to Radiation Workers .....	6
	4.3	Departmental Limitations to Radiation Workers .....	6



4.4	Personnel Exposure Monitoring Devices . . . . .	6
4.5	Body Protection . . . . .	7
4.6	Food Handling . . . . .	7
4.7	Smoking . . . . .	7
4.8	Personal Cleanliness . . . . .	7
4.9	Gloves . . . . .	7
4.10	Pipetting . . . . .	7
4.11	Technicians and/or Collaborators . . . . .	7
4.12	Terminating or Transferring Employees . . . . .	7
4.13	Visitors . . . . .	8
4.14	Service Personnel . . . . .	8
4.15	Notice to Employees . . . . .	8
4.16	Training and Experience . . . . .	8
4.17	Notices, Instructions, and Reports to Workers; Inspections . . . . .	8

Section	5.0	Rules and Requirements Concerning the Laboratory . . . . .	8
	5.1	General . . . . .	8
	5.2	Laboratory Facilities . . . . .	9
	5.3	Laboratory Hoods . . . . .	9
	5.4	Work Surfaces, Walls, and Floors . . . . .	9
	5.5	Trays . . . . .	9
	5.6	Particulate and Airborne Materials . . . . .	9
	5.7	Shielding . . . . .	9
	5.8	Handling Tools . . . . .	10
	5.9	Area Warning Signs . . . . .	10
	5.10	Container Labels . . . . .	10
	5.11	Radioactive Waste-Storage Containers . . . . .	10
	5.12	Storage of Radioactive Materials . . . . .	10
	5.13	On-Site Transport Containers . . . . .	10
	5.14	Removal of Equipment . . . . .	10
	5.15	Packaging and Shipment . . . . .	10
	5.16	Instrumentation . . . . .	11
	5.17	Monitoring Requirements . . . . .	11
	5.18	Laboratory and Equipment Surveys . . . . .	11
	5.19	Contaminated Equipment . . . . .	12
	5.20	Contaminated Work Surfaces . . . . .	12
	5.21	Contaminated Clothing . . . . .	12
	5.22	Spills and Decontamination . . . . .	12
	5.23	Separate Counting Room . . . . .	12
	5.24	Animal Wastes . . . . .	12
	5.25	Unusual Handling Procedures . . . . .	12
	5.26	Small Animal Experiments . . . . .	12
	5.27	Release of Radioisotope Laboratory for Unrestricted Use . . . . .	13

Section	6.0	Rules and Requirements Concerning Field Experiments . . . . .	13
	6.1	General . . . . .	13
	6.2	USNRC Approval . . . . .	13
	6.3	Committee Approval . . . . .	13
	6.4	Field Experiments on Land Not Under Control of the USDA . . . . .	13

	6.5	Control of Persons .....	13
	6.6	Monitoring .....	13
	6.7	Crop and Waste .....	13
Section	7.0	Rules and Requirements Concerning Sealed Sources .....	14
	7.1	General .....	14
	7.2	Request for Approval .....	14
	7.3	Source Tagging and Labeling .....	14
	7.4	Radiation Warning Signs .....	14
	7.5	Storage Security .....	14
	7.6	Instructions to Assistants .....	15
	7.7	Miscellaneous Sealed Source Requirements .....	15
	7.8	Leak Testing of Sealed Sources .....	15
	7.9	Performance of Leak Tests .....	15
	7.10	Kinds of Leak Tests .....	16
	7.10.1	Wipe Test .....	16
	7.10.2	Scrub Test .....	16
	7.10.3	Immersion Test .....	16
	7.10.4	Cellulose Tape Test .....	16
	7.11	Leak Test Results and Reports .....	16
	7.12	Special Requirements of Neutron Soil Moisture and Soil Density Gages Containing Sealed Sources .....	17
	7.12.1	General .....	17
	7.12.2	Training and Experience Requirements .....	17
	7.12.3	Request for Approval Requirements .....	17
	7.12.4	Radiological Safety Requirements .....	17
	7.13	Special Requirements for Civil Defense Preparedness Agency Cobalt 60 Sealed Source Sets .....	18
	7.13.1	General .....	18
	7.13.2	Training and Experience Requirements .....	18
	7.13.3	Request for Approval Requirement .....	19
	7.13.4	Radiological Safety Requirements .....	19
	7.13.5	Cancellation of Letter of Authorization .....	19
	7.14	Special Requirements and Privileges for Radioactive Sources in Gas Chromatographs (GC) .....	19
	7.14.1	General .....	19
	7.14.2	Radiological Safety Requirements .....	19
	7.14.3	Privileges Associated With GC Authority .....	19
	7.14.4	Leak Testing Requirements .....	20
Section	8.0	Rules and Requirements Concerning X-Ray Machines Up to 110 KVP .....	20
	8.1	General .....	20
	8.2	Training and Experience Requirements .....	20
	8.3	Request for Approval Requirements .....	20
	8.4	Radiological Safety Requirements .....	20
	8.5	High-Energy Machines .....	21
Section	9.0	Rules and Requirements Concerning Electron Microscopes (EM) .....	21
	9.1	General .....	21
	9.2	Training and Experience Requirements .....	22

	<i>Page</i>
9.3 Request for Approval Requirements .....	22
9.4 Radiation Safety Requirements .....	22
Section 10.0 Rules and Requirements Concerning Emergencies .....	22
10.1 General .....	22
10.2 Primary Emergency Procedures .....	22
Section 11.0 Reference Material .....	23
11.1 Federal Regulations .....	23
11.2 National Council on Radiation Protection (NCRP) .....	23
11.3 Selected Bibliography .....	23
Appendix .....	24



# RADIOLOGICAL SAFETY HANDBOOK

Prepared by C.Z. Kwast, *radiological safety officer*, and H. Roberts, Jr., *Assistant radiological safety officer*,  
*Office of the Administrator, Agricultural Research Service*

## SECTIONS 1.0 - 11.0

### Section

1.0 *Definitions of Pertinent Terms Used in This Handbook*

1.1 *Radioactive Material.* Radioisotopes, by-product materials, neutron sources, naturally occurring radioactive substances, and any materials in sealed or unsealed form, that spontaneously emit radioactive particles and/or rays.

1.2 *Radiation-Emanating Equipment.* Devices containing radioactive sealed sources, such as soil moisture and density gages or irradiators, and apparatuses capable of producing ionizing radiation in potentially hazardous quantities such as X-ray machines, electron microscopes, particle accelerators, static eliminators, and neutron generators.

1.3 *Prospective User.* Individual who contemplates using radioactive material and/or radiation-emanating equipment independently, has submitted a Request for Approval, and is awaiting written decision from the Committee.

1.4 *Authorized User.* The individual approved by the Committee to independently use radioactive material and/or radiation-emanating equipment and who is responsible for their proper and safe use by himself and/or his subordinates.

1.5 *10-CFR-20.* Title 10 Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," published in the Federal Register by the USNRC to which reference frequently will be made in this handbook.

1.6 *Radiation Protection Officer.* Qualified individual specifically authorized by the Committee in writing to be responsible for radiological safety matters at a particular field station or laboratory. He reports to the

Committee and the RSO and is required to apply the rules and regulations specified in this handbook.

1.7 *Radioactive Contamination.* Radioactive material present in or on any other material or objects where it is not desired and particularly where its presence may be harmful. The harm may be in vitiating the validity of an experiment or a procedure or in actually being a source of danger to personnel.

1.8 *Background Radiation.* Radiation arising from radioactive material other than the one directly under consideration. Radiation due to fallout, to cosmic rays, to natural radioactive material in the vicinity, and to a slight radioactive contamination of materials of which measuring instruments are made.

1.9 *Sealed Source.* Any radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.

1.10 *Ionizing Radiation.* Any radiation such as alpha, beta, gamma, neutrons, or X-rays that directly or indirectly displaces electrons from the outer domains of atoms and thereby produces ions in its passage through matter.

### Section

2.0 *Rules and Requirements Concerning Approval for Radioactive Materials and/or Radiation-Emanating Equipment*

2.1 *Acquisition.* The acquisition of radioactive materials, regardless of quantity of activity, and/or radiation-emanating equipment by purchase or by any other means is prohibited *without prior approval of the Committee*, except in those cases where manufacturers of counting or surveying instrumentation furnish small check standards as an integral part of the



instrumentation. At no time shall any prospective user make application directly to the USNRC for approval to possess and to use radioactive material and/or radiation-emanating equipment. The prospective user should also follow internal procedures his agency has established for submitting a Request for Approval (see section 2.6 below) to the Committee.

2.2 **Use.** Radioactive materials and/or radiation-emanating equipment shall be used by authorized users in accordance with generally accepted safe practices, the rules and procedures specified in this handbook, and as specifically prescribed by the Committee and/or RSO. All experiments or other activities conducted in open fields or areas (where radioactive material may be lost to the environment as opposed to those conducted within a laboratory, greenhouse, or other controlled facility) shall have prior specific Committee approval (see sections 6.0 and following, p. 13).

2.3 **Transfer of Materials or Equipment.** Transfer, exchange, or other disposition of radioactive materials and/or radiation-emanating equipment to other laboratories, stations, or individuals shall not be made without prior approval of the Committee except as specifically stated in this handbook.

2.4 **Cooperative Work Projects.** Where cooperative work projects involving the use of radioactive material and/or radiation-emanating equipment are conducted under the supervision of *other* than a Department agency, an employee of the Department shall not participate in such projects without prior approval of the Committee.

2.5 **Research in Non-USDA Facilities.** Use of radioactive materials or radiation-emanating equipment by a Department employee in a non-USDA facility (such as a university laboratory) shall not be effected unless prior official written approval has been obtained from both the non-USDA facility and from the Committee. In such case the authorized user shall follow the provisions of this handbook as well as any special procedures prescribed by the facility. The non-USDA approval should be

submitted to the RSO with the prospective user's Request for Approval described below.

## 2.6

**Request for Approval.** Any person planning to undertake research involving the use of radioactive material and/or radiation-emanating equipment shall prepare and submit to the RSO a Request for Approval in the form of a letter or memorandum containing the information outlined below. This letter or memorandum, preferably prepared by the prospective user, shall be submitted and a reply received *before any procurement action is initiated*. (See sections 7.0 and following, p. 14 for rules concerning sealed sources and special requirements for certain large sources.)

- A. A brief statement of the objectives of the undertaking.
- B. A description of the facilities to be used, including details of laboratory, greenhouse, and/or field facilities and equipment. Where applicable, include description of the equipment to be used for handling; instrumentation to be used for monitoring, surveying, and assaying; facilities for storage; and methods of waste disposal.
- C. A detailed description of the plan of work when radioactive material is involved including method of application and assay procedures to be used if applicable.
- D. A statement of the prospective user's qualifications to safely handle, use, and measure radioactive materials and/or radiation-emanating equipment. OA Form 30 (appendix B, p. 31) is available from the RSS and should be used for submitting radiation training and experience information for each user to be authorized. (See section 4.16, p. 8.)
- E. When a radioisotope is to be used, a statement of the kind, an estimate of the maximum amount in millicuries to be on hand at any one time, and the desired chemical form(s). When radiation-emanating equipment is used, its make, model number, quantity of activity in source, if appropriate, and the manufacturer's descriptive literature, if available.



- 2.7 **Followup.** The RSO will contact the prospective user if additional information is needed or will explain specific requirements necessary to be satisfied prior to action by the Committee. Following this, the RSO will initiate Committee action.
- 2.8 **Notice of Action.** Notification of action by the Committee will be by memorandum to the prospective user from the RSO and will either authorize or deny the use of ionizing radiation. When favorable, the notice shall be used by the authorized user as authority, from a radiation safety standpoint, to request procurement action. Notice will include special instructions, Committee identification number, and forms as necessary to effect acquisition of material and/or equipment.
- 2.9 **Purchase Procedure.** Following receipt of Notice of Action, the authorized user should prepare his requisition form and submit it to his Procurement Office, which shall prepare and process the purchase order in accordance with Section IX of AM 124.1 (appendix A, p.25). All requisitions and purchase orders for radioactive materials and/or radiation-emanating equipment shall bear the Committee identification number appearing in the Notice of Action and the Statement "Radioactive Material (or Radiation-Emanating Equipment) for (name of authorized user)." Unless advised otherwise by the RSO in Notice of Action, shipments should be consigned to the authorized user. Choice of commercial suppliers of radioactive materials or equipment is left to the discretion of the authorized user, but the RSO will make recommendations upon request. It is emphasized that *the original and two copies of the purchase order shall be submitted to the RSS.*
- 2.10 **Modification of Research Proposal.** Any significant changes in the research proposal or radioisotopes used as originally presented and approved shall be submitted for further Committee review and approval before such changes are effected.

## Section

- 3.0 **Rules and Requirements Concerning Receipt, Use, and Disposal of Radioactive Materials and/or Radiation-Emanating Equipment**

- 3.1 **Receipt of Materials.** Packages containing radioactive materials shall be picked up pursuant to procedures in Section 20.205, 10-CFR-20, surveyed by the consignee, opened carefully in hood, and checked for possible breakage and kind, quantity, and acceptability of contents. Receipt of all radioactive and/or radiation-emanating equipment, regardless of method obtained (includes those received gratis), shall be reported to the RSS on OA Form 2, "Report of Receipt of Radioactive Materials" (appendix C, p. 33) within 2 days after the shipment is received. All appropriate items on this form shall be completed. When radiomaterials are received gratis, name of supplier shall appear in Item 10. An original and one copy of OA Form 2 will be furnished the authorized user by the RSS at the time the purchase order is processed by the RSS or upon request. The completed original shall be returned to the RSS and the copy shall be retained by the user for his files.
- 3.2 **Use of Materials or Equipment.** Use of radioactive materials and/or radiation-emanating equipment shall be in accordance with (1) generally accepted safe practices and procedures, (2) procedures described in Request for Approval submitted by the prospective user and subsequently approved by the Committee in its Notice of Action, (3) applicable rules and requirements specified in this handbook, and (4) the special instructions imposed by the Committee and/or RSO, if any.
- 3.3 **Special Reports.** In addition to specific reports required by these rules, special reports of monitoring, survey, and exposure may be required by the RSO. Such special reports will be scheduled by the RSO at the time of, or prior to, initiation of the work. Reporting requirements may be modified only by written authorization of the RSO.
- 3.4 **Radioactive Waste Disposal.** Disposal of radioactive wastes shall be in accordance with the requirements of section 20.301, 10-CFR-20 (appendix D., p. 34). Incineration of radioactive waste **IS PROHIBITED** by section 20.305, except as specified. Any departure from the requirements of 10-CFR-20 must be covered by specific amendment to the license approved and issued by the USNRC pursuant to

section 20.302 of 10-CFR-20. Disposal methods recommended by the National Committee on Radiation Protection (NCRP) as published in NCRP Report No.30 (appendix J, p. 59) may be used as a guide for application. Such application, however, shall be submitted to the RSO who will make application to the USNRC.

3.4.1 **Radioactive Waste-Disposal Records.** Waste-disposal records are required and shall be completed by the authorized user on OA Form 3, "Radioisotope Waste Disposal Report" (appendix E, p. 53). Disposal of all material procured under a particular purchase order number or received gratis must be accounted for on OA Form 3. However, if only a portion of the total material procured is used and/or disposed of, an entry shall be made on OA Form 3, but the form shall *NOT* be submitted to the RSS until *ALL* the material has been used and/or disposed of. Records shall be maintained in microcurie units whenever possible. OA Form 3 will be furnished the authorized user by the RSS when the purchase order is processed by the RSS or upon request. The completed original shall be returned to the RSS and a copy shall be retained by the user for his files.

3.4.2 **Radioactive Waste Preparation.** Solid radioactive waste shall be properly wrapped to preclude the possibility of external contamination. Wrapping material must be strong enough to be punctureproof. Breakable or broken glassware and other noncombustible or compressible material shall be wrapped separately. Packages containing corrosive material shall be so wrapped as to protect the wrapping from disintegration. Liquid radioactive waste not disposable via the sewerage system shall be poured into break-resistant containers or bottles and tightly capped. All packages and containers shall be appropriately marked with the standard tag or label which shall also show the isotope, estimated quantity in microcuries, and date. Individual packages or containers that read in excess of 50 mR per hour at the surface shall not be placed in large waste containers (section 5.11, p. 10) but shall be handled and disposed of separately. In those rooms or areas where appropriately marked plastic-lined con-

tainers are provided, the containers may be assumed to constitute the package and individual container labeling is unnecessary. Radioactive waste that is ready for pickup and disposal shall be placed into durable disposal containers that can be handled without danger of breakage or spillage of their contents.

3.4.3 **Radioactive Waste Storage.** Radioactive wastes shall be stored in appropriate containers (section 5.11, p. 10) located either in individual laboratories or in a controlled room or area until such time that their final disposal is accomplished. The storage site shall not be accessible to unauthorized personnel. The place of storage should be chosen so as to minimize risk from fire. The radiation level shall not exceed 1 mR per hour at closest normal approach to the radioactive waste.

3.4.4 **Disposal of Short Half-life Radioactive Waste.** Where possible without undue difficulty, wastes of short half-life (30 days or less) should be segregated so they may be stored for decay. Solid radioactive wastes such as contaminated paper cups, tissues, and empty containers that were used for short half-life radioisotopes may be stored in a closed, properly labeled container in a controlled room or area for decay to background level as measured by a suitable and properly operating survey meter. These articles may then be disposed of as nonradioactive trash after removal or destruction of radiation warning labels. Short half-life liquid radioactive wastes may be stored for decay in a similar manner and thereafter disposed of via the sewerage system provided their other characteristics are not objectionable.

3.4.5 **Disposal by Release Into Sanitary Sewerage System.** When disposition of a soluble and/or dispersible radioactive material is made via the sewerage system, the material shall be sufficiently diluted with water prior to its *release* so that the concentration limits specified in appendix B, table I, column 2, 10-CFR-20, will not be exceeded. The quantity so released shall be entered in MICROCURIE UNITS in item 8 of OA Form 3, together with the amount of water used as a diluent, so that a calculation in units of MICROCURIES PER MILLIMETER can be made. This calculation shall appear in Item 13 to confirm that the



concentration limit has not been exceeded. Septic tanks and systems other than large municipal-type, sewerage-disposal systems are not acceptable for disposal of liquid radioactive wastes except for short half-life wastes that have decayed to background level after appropriate storage.

3.4.6 *Disposal by Burial.* (This section applies to laboratories or stations other than Beltsville, Md.) Owing to the possible future use for other purposes of land that has been used as a radioactive waste burial site, the Committee recommends that, whenever possible, disposal methods *other than burial*, as specified in this handbook, be employed. However, when disposition of radioactive materials is to be by burial in soil, prior Committee approval shall be obtained and the quantities buried at any one location and time shall not exceed, at the time of burial, 1,000 times the amount specified in appendix C, 10-CFR-20. The remaining provisions of section 20.304, 10-CFR-20, shall also be satisfied. Burial shall be accomplished on land owned by the Department in an area from which the public can be excluded and whose long-range use for other purposes is not planned. A written record identifying each radionuclide, quantity of each in microcuries, physical form (that is liquid or solid), date of burial, and specific burial location shall be maintained and made available to the RSS upon request. Further, where water tables are high or the contamination of potable waters is possible, disposal by burial shall not be used. Projects that involve the use of animals should be planned, where possible, to minimize the number of burials that must be made. Inquiries regarding burial shall be directed to the RSO.

3.4.7 *Disposal by Incineration.* The Committee emphasizes that disposal of radioactive waste by incineration is **NOT PERMITTED** unless a proposal is submitted to the Committee pursuant to section 20.302, 10-CFR-20, and the RSO, in turn, applies to and receives authority from the USNRC. Questions or proposals regarding incineration shall be directed to the RSS.

3.4.8 *Disposal by Transfer to Authorized Recipient.* Section 20.301 (a), 10-CFR-20, authorizes the disposal of radioactive waste by transfer to a

USNRC or an Agreement State authorized recipient. If a field laboratory or station finds it necessary or expedient to transfer its radioactive wastes to an authorized commercial waste disposal firm, detailed information, including costs, for such service should be obtained directly from the firm. Upon request, the RSS will furnish names and addresses of firms licensed to receive radioactive wastes. As with other methods of disposal, OA Form 3 shall be appropriately completed and submitted to the RSS to record the transfer and disposal of radioactive materials. The name and address of the disposal firm shall be entered in Item 13, OA Form 3.

3.5 *Inventory Records.* The authorized user shall maintain an accurate inventory of radioactive materials and/or radiation-emitting equipment under his control so that a report can be prepared and submitted when requested by the RSS.

#### Section

4.0 *Rules and Requirements Concerning Personnel*  
4.1 *General.* Radiation protection and contamination control are necessary for the safety of personnel and for protection of property. Methods for radiation protection and contamination control are outlined in NCRP Report No. 8 (appendix J, p. 59). Typical hazards involved in the handling of radioactive material and/or radiation-emitting equipment are the following:

- A. Inhalation, ingestion, or absorption of radioactive material within the body.
- B. Exposure of the body to sources of gamma, X, or neutron radiation external to the body.
- C. Exposure of the body to sources of alpha or beta radiation.
- D. Exposure of the hands or other limited parts of the body to alpha, beta, neutron, gamma, or X-radiation.

The first of these is thought of as an internal hazard, and the others are thought of as external hazards. The fundamental purpose of all protective measures is to prevent or to limit exposure to these hazards by such means as (1) prevention of ingestion, inhalation, penetration through breaks in skin or

other modes of entry of radio-active material into the body and (2) reduction of the exposure from external sources of radiation to below permissible levels. Aside from these needs for personal safety, control of contamination is a desirable laboratory practice so as to achieve a low background count for accurate and reliable counting statistics. Generally, when the background radiation is maintained at an acceptable level from this standpoint, there can be no hazard to health. Notwithstanding protective measures that are observed, persons less than 18 years old should not be employed to work with radiation. Whenever practicable, women of childbearing age should not be assigned to work with radiation. Women who are pregnant shall not be exposed to ionizing radiation.

- 4.2 **Maximum Permissible Exposure to Radiation Workers.** The maximum permissible exposure limits to workers in restricted areas are specified in section 20.101, 10-CFR-20, as follows:

	<i>Rems per calendar quarter</i>	<i>Millirems per 40-hour week</i>
A. Whole body; head and trunk active blood-forming organs; lens of eyes or gonads . . . . .	1-1/4	100
B. Hands and forearms; feet and ankles . . . . .	18-3/4	1,442
C. Skin of whole body . . . . .	7-1/2	577

Notwithstanding the above, these limits may be used as working limits only with written approval of the Committee, and users will normally be required to follow the Departmental limits specified in section 4.3 below.

- 4.3 **Departmental Limitations to Radiation Workers.** Experience has shown that owing to improvements in equipment shielding, protection guidance, and protection techniques, levels of less than one-fourth the 10-CFR-20 current permissible 40-hour week levels are consistently attained in substantially all applications of radioactive materials and/or radiation-emanating equipment throughout the

Department's laboratories and field stations. Accordingly, unless specific exceptions are approved by the Committee, the maximum permissible whole body exposure limit shall not exceed 25 millirems per 40-hour week.

- 4.4 **Personnel Exposure Monitoring Devices.** Users of radioactive materials and/or radiation-emanating equipment shall wear film badges and/or other personnel monitoring devices when required by the Committee at the time the use of such materials and/or equipment is authorized. Customarily, personnel monitoring *IS* required when neutron-emitting, gamma-emitting, and/or strong beta-emitting radioactive materials such as  $^{32}\text{P}$  are used, and *IS NOT* required when weak beta-emitting radioactive materials such as  $^{14}\text{C}$  or  $^3\text{H}$  are used. The Department has a contract for film badge service with a commercial supplier, which all employees requiring film badge service shall use unless specific approval for other personnel monitoring service is obtained from the Committee. Requests for film badge service, and all subsequent modifications thereto, shall include the name, date of birth, and social security number of each person to be assigned a badge and shall be submitted at least 4 weeks before the badges are needed to the RSS who will initiate the film badge service. Unassigned film badges (badges having no specific names thereon) for temporary or for visitor use may also be included. When unassigned badges are used, a written log showing badge number, name of wearer, and date(s) worn shall be maintained. In addition, a quarterly report shall be submitted to the RSS on OA Form 4, "Unassigned Film Badge Use Report," (see appendix I, p. 58) available from the RSS. If film badges will not be needed for a period of 3 months or more, request to discontinue service should be submitted to the RSS. Service can be reinstated when needed by following the procedure stated above. Detailed instructions for proper handling and use of film badges will be furnished at time film badge request is processed by the RSS. General rules for film badges are as follows:

- A. Film packets in badge holders shall be exchanged and returned to the supplier regardless of whether they are used.



- B. Film badges shall not be subjected to extreme temperatures and humidity or be tampered with.
- C. When not in use, film badges shall be stored with control badge in place where radiation is lowest.
- D. Film badges should be worn at waist or shirt pocket level and outside all clothing.

Film badge exposure reports prepared by the supplier will be mailed directly to the RSS. If a wearer's exposure exceeds 100 milliroentgens (per 1-month use period for film badge), he will be notified and required to submit a written report explaining circumstances accounting for the "overexposure" and corrective action taken to preclude similar overexposures in the future. When other personnel monitoring devices such as pocket dosimeters are required by the Committee, their procurement costs must be assumed by the user's laboratory or station. When pocket dosimeters are used, a written log showing (1) dosimeter number, (2) name of wearer, (3) date(s) worn, (4) time IN, (5) time OUT, (6) dosimeter reading IN, and (7) dosimeter reading OUT shall be maintained and made available to the RSS upon request.

4.5 *Body Protection.* Users shall wear special protective clothing, such as approved respirators, face guards, gloves, and shoe covers, as prescribed by the Committee. When bulk or liquid radioactive materials are used, laboratory coats shall be worn that (1) shall be buttoned, (2) shall not be worn out of the laboratory area, (3) shall not be stored with street clothes, (4) shall be monitored periodically and always prior to being sent to the laundry, and (5) shall be decontaminated or disposed of if the contamination exceeds three times background. Coats or protective equipment contaminated with a short half-life radioisotope may be stored until contamination decays to background level.

4.6 *Food Handling.* No foods or drinks shall be stored, prepared, or consumed in rooms or areas in which radioactive materials are used or stored. Food or drinks shall not be stored in refrigerators used for storage of radioactive materials.

4.7 *Smoking.* Smoking shall not be permitted in rooms or areas in which radioactive materials are used.

4.8 *Personal Cleanliness.* Hands shall be thoroughly washed before eating, smoking, applying cosmetics, or leaving work area.

4.9 *Gloves.* Rubber or plastic gloves shall be worn in any situation where solutions of radioactive materials are handled or where contamination by such solutions is possible (that is, harvesting of fresh plant material, opening vials, sampling animal carcasses or excreta, and handling waste materials). Gloves shall be left in laboratory or appropriate area. Contaminated gloves shall be washed before being removed or be disposed of as radioactive waste.

4.10 *Pipetting.* Pipetting of radioactive solution by mouth is prohibited regardless of the activity concentration since many types of mechanical pipettors are available.

4.11 *Technicians and/or Collaborators.* Laboratory technicians and/or collaborators working under the direct personal supervision of an authorized user may participate in the use of the radioactive materials and/or radiation-emanating equipment approved by the Committee provided the authorized user has advised the Committee and has instructed the technicians and/or collaborators in the proper and safe use of the materials and/or equipment, the potential hazards associated with improper use, and is available to answer questions or if an incident occurs. In such case, the authorized user is responsible for the health and safety of the technicians and/or collaborators involved. Technicians and/or collaborators shall *not* procure and use radioisotopes and/or radiation-emanating equipment independently without prior approval of the Committee.

4.12 *Terminating or Transferring Employees.* Authorized users who plan to terminate employment with the Department or to transfer to a new location are responsible for proper disposition of all radioactive materials and/or radiation-emanating equipment in their custody *before* they leave. The RSO shall be notified of such termination or transfer and disposition of materials or equipment at least 3 weeks before the termination or transfer is effective. Materials or equipment disposed of as radioactive waste shall be reported on appropriate OA Form 3. If responsibility for materials or equipment will be transferred to

another authorized user, the RSO shall be notified either to authorize the transfer or, if the transfer is inappropriate, to advise on proper procedures. It is imperative that each quantity of radioactive material or piece of equipment disposed of or transferred be accurately identified and accounted for.

- 4.13 *Visitors.* Access to radiation laboratories by visitors should be held to a minimum. When visits are necessary, visitors shall be given the same personnel monitoring coverage as regular personnel working in a radiation laboratory. It is not necessary to provide individual personnel monitoring devices for large groups of visitors if the potential exposure is low. Instead, personnel monitoring devices shall be issued only to the escorts accompanying these large groups. The escort should note on the visitor log that he is acting as escort for the group. Individual visitors or those in small groups who might be expected to move around unescorted shall be issued individual personnel monitoring devices (section 4.4, p. 6).
- 4.14 *Service Personnel.* Protective, custodial, maintenance, animal handler, and repair personnel shall not be permitted into laboratories or areas in which radioactive materials and/or radiation-emanating equipment are used or stored unless they have been properly indoctrinated in the meaning of warning signs and fully instructed in safe practices in their work in restricted areas. Such instruction shall be given by the authorized user or the RPO prior to the start of work. Custodial or craft supervisors shall be fully informed of any restrictions imposed.
- 4.15 *Notice to Employees.* Form NRC-3, "Notice to Employees," shall be conspicuously posted in a sufficient number of places where employees working in or frequenting any portion of a restricted area may observe a copy on the way to or from their place of employment. This form is available from the RSS.
- 4.16 *Training and Experience.* A prospective user who expects to be an authorized user shall have acceptable training and experience in the use of radioactive materials and/or radiation-emanating equipment. These can consist of formal college courses and laboratory exercises or short-term specialized courses of instruction as offered by universities, industries, and

Government agencies. Alternatively, the Committee will evaluate previous on-the-job training and active participation in laboratory procedures under the direct personal supervision of a well-qualified user and of sufficient duration to furnish the prospective user the basic knowledge to use ionizing radiation safely and efficiently. Training should include such subjects as (1) principles and practices of radiation protection, (2) radioactivity measurement, standardization, and monitoring techniques and instruments, (3) mathematics and calculations basic to the use and measurement of radioactivity, (4) biological effects of radiation, and (5) safe operation of the more common radiation-emanating devices (for example, X-ray machines or electron microscopes).

- 4.17 *Notices, Instructions, and Reports to Workers; Inspections.* New 10-CFR-Part 19 (appendix K, p. 60) bearing the title of this paragraph has been published by the USNRC to enable a worker to become familiar with information affecting his health and safety that he is entitled to receive from the licensee and options he has in connection with physical inspections conducted by the USNRC. Copies of regulations, operating procedures, and related documents are available for examination from the authorized user, RPO, or RSS.

## Section

### 5.0 *Rules and Requirements Concerning the Laboratory*

- 5.1 *General.* Safety in the laboratory using radioactive materials requires vigorous and careful observance of normal laboratory safety requirements, their common sense extension to fit the special application of radioactivity, and the important requirement that each user be competent and responsible. The safe use of radioactive materials is dependent on the use of proper facilities and equipment, the establishment of good housekeeping and work habits, and suitable waste disposal procedures. In some circumstances it may be necessary to apply time, distance, and shielding factors. Exposure varies (1) directly with time of exposure, (2) inversely with the square of the distance to a point source, and (3) inversely with the absorption of radiation by the shielding material.



5.2 **Laboratory Facilities.** The laboratories in which radioactive materials and/or radiation-emitting equipment are used should be designed for such use and must be approved by the Committee. Whenever possible, radioisotope laboratories should be restricted to such use. A section of a chemical laboratory may be used for radioisotope work provided it is isolated and properly posted. Committee recommendations on details of laboratory facilities may be obtained from the RSS.

5.3 **Laboratory Hoods.** Most laboratory operations involving radioactive materials other than the lowest level (that is, counting sample preparation) shall be conducted in an approved hood. Operations such as dilutions, distillations, or chemical digestions in which there is hazard of explosion, splatter, spillage, and formation of gases, fumes, or vapors shall be performed in hoods. Prior to their use, all hoods shall be approved by the Committee. The following minimum requirements shall be met to obtain approval:

- A. Hoods shall have individual exhaust systems whenever possible and shall be operating when radioactive materials are used.
- B. Linear air velocity at face of hood with sash opened maximum amount shall be about 125 linear feet per minute.
- C. Hood design shall minimize turbulence and eddies at hood face.
- D. Exhaust system shall provide for the insertion of suitable filters when required that will limit effluent concentrations to those permitted by 10-CFR-20.
- E. Hood structure shall be sufficiently strong to support lead shielding and surfaces should be smooth, easily decontaminatable, and corrosion resistant. Hood surfaces other than stainless steel or plastic shall be corrosion resistant. Hood surfaces other than stainless steel or plastic shall be covered with a strippable epoxy paint which can be removed when it becomes contaminated.  
For proper fume control, all operations shall be conducted beyond a safety line 6-8 inches inside the face of the hood.
- G. Service outlets such as air, gas, water,

and vacuum shall be so located that the operator will not have to reach into the hazardous zone to make hose connections.

- H. Effluents shall be discharged from duct or stack which extends at least 4 feet above roof line. Care shall be taken that the exhausted contaminant is *not* discharged near any open windows or air-ventilation intake where it could be recirculated into the laboratory.
- I. Exhaust blower shall be located as near to the top of the stack as possible, that is, it should be mounted under the building roof, not on top of the hood.
- J. Air intake to heating or air-conditioning system shall be closed when radioisotopes are used and hood is ON to prevent recirculation of laboratory air.

5.4 **Work Surfaces, Walls, and Floors.** Work surfaces and floors, including greenhouses and animal barns, where radioactive materials are used shall be treated to decrease retention of contamination. Asphalt or vinyl tile or linoleum is recommended when carefully laid and waxed with several coats of water-insoluble wax. Absorbent, waterproof-backed covering shall be used on work surfaces, in trays, and so forth. Polyethylene shall be used around animal stalls and cages to retain contaminated animal wastes. Concrete floors should be painted with commercially available sealants and paints that are readily decontaminatable or can be removed if necessary. Walls shall be painted with a smooth durable paint that can be easily cleaned and decontaminated if necessary.

5.5 **Trays.** Stainless steel or plastic trays lined with absorbent paper shall be used on work surfaces and in hoods. Experiments should be set up in such trays and contaminated equipment placed thereon.

5.6 **Particulate and Airborne Materials.** Work involving radioactive material in volatile, dust, aerosol, or gaseous form shall be conducted in a closed system, glove box, or in a hood unless special conditions justify written authorization from the Committee for modification of this requirement.

5.7 **Shielding.** Shielding shall be used in such manner that the radiation level at the user's

working position will not exceed one milliroentgen per hour when gamma or hard beta-emitting radioisotopes are used.

- 5.8 **Handling Tools.** Appropriate remote handling tools shall be available and used particularly when handling beta and gamma emitters. The Committee may require the use of special remote handling tools and equipment.
- 5.9 **Area Warning Signs.** Any laboratory, room, or area approved for use or storage of radioactive materials and/or radiation-emanating equipment shall be appropriately posted in accordance with section 20.203 (a) through (e) of 10-CFR-20. Warning signs are essential, since individuals might otherwise be unaware of the presence of a radiation field. However, signs should not be used when they are not needed. Standard radiation warning signs, labels, and tags should be purchased from commercial suppliers, but the RSS will furnish limited quantities upon request.
- 5.10 **Container Labels.** Each container or equipment in which radioactive material is used and/or stored shall be labeled in accordance with the applicable requirements of section 20.203 (f), 10-CFR-20. Containers used strictly for storage shall also include (1) the kind of radioactive material, (2) the quantity of material, and (3) the date of measurement of the quantity. Do not leave laboratory with unlabeled radioactive items on benches, in hoods, and so forth.
- 5.11 **Radioactive Waste-Storage Containers.** Each laboratory in which radioactive materials are used shall have at least one container for solid radioactive waste storage and one for liquid radioactive waste storage. The container for solid wastes may be one of the usual type, that is, GI can or large plastic container, that shall be lined with a durable disposable plastic bag. Polyethylene jugs or carboys are best for storing liquid wastes, although disposable metal cans with leakproof covers may be used. Glass or leakable containers shall not be used for storage of liquid radioactive wastes. Waste containers shall have securely fitting covers and shall be marked with a radioactive hazard sign reading CAUTION - RADIOACTIVE MATERIAL. Maintenance employees, janitors,

custodians, and so forth, should be repeatedly cautioned by authorized users, by their supervisors, or by the RPO never to empty radioactive waste containers with regular trash.

- 5.12 **Storage of Radioactive Materials.** Quantities of radioactive materials in excess of those needed for transient use and portable radioactive sealed sources shall be stored in a locked cabinet to prevent unauthorized use or removal. The place of storage should be chosen so as to minimize risk from fire. Sufficient shielding shall be used to reduce the radiation level to one milliroentgen per hour or less at closest approach to the radioactive material. Bottles containing radioactive liquids should be placed in plastic or metal vessels large enough to hold the entire contents of the bottles in case of breakage. Many bulk radioisotopes decompose on storage and the decomposition is accelerated by self-radiolysis, thermal instability, photosensitivity, etc. Rather than store excess compounds and maintain burdensome inventory records, whenever feasible dispose of labeled compounds as waste and report them on appropriate OA Form 3.
- 5.13 **On-Site Transport Containers.** Radioactive materials that must be moved within a laboratory or from one laboratory to another approved laboratory at the same location shall be transported in containers that minimize the danger of breakage, spillage, and exposure to personnel. Solutions shall be placed in double containers, that is, volumetric flasks placed in metal containers with absorbent liners.
- 5.14 **Removal of Equipment.** Laboratory glassware and other equipment involved in use of radioactive materials shall not be removed from the laboratory and shall not be mixed with "clean" equipment until demonstrated to be free of contamination. A marked storage shelf or cabinet shall be provided for glassware and tools used in radioactive work if the laboratory is not used solely for radioactive materials.
- 5.15 **Packaging and Shipment.** Packaging and shipment of radioactive materials and/or radiation-emanating equipment must be in accordance with complicated and strict U.S. Department of Transportation or USNRC regulations and with



applicable State and local regulations. When it is necessary to package and ship radioactive materials by common carrier, by the U.S. Postal Service, or by other means, the RSO shall be contacted for appropriate packaging and shipping instructions.

- 5.16 *Instrumentation.* Each laboratory shall have available a properly operating monitoring instrument suited to the type of radiation involved unless specifically stated otherwise in this handbook. The instrument should be calibrated at least every 6 months in accordance with accepted procedures. The selection of laboratory counting and analysis systems is left to the discretion of the authorized user, but the RSO will make recommendations upon request.
- 5.17 *Monitoring Requirements.* Authorized users are expected to routinely monitor and record in their research-data notebooks the radiation level at significant steps in their use of radioactive materials, that is, at dilution, distillation, volume reduction, crystallization, and so forth. Laboratory surveys shall be performed as described in section 5.18 below. Special monitoring requirements shall be imposed on users of sealed sources and radiation-emanating equipment.
- 5.18 *Laboratory and Equipment Surveys.* Federal regulations and Department rules require the performance of surveys on a regular basis to evaluate the potential radiation hazards associated with the use of radioisotopes and/or radiation-emanating equipment. Specifically, this instruction applies to all laboratory radioisotope use, to sealed sources when used in laboratory setups, and to radiation-emanating equipment such as X-ray devices, electron microscopes, and so forth. In general, the monitoring program should consist of surveys to evaluate equipment, facilities, and procedures to establish that they are in compliance with applicable safety rules and regulations and to determine radiation levels and radioactive contamination where appropriate. The survey shall be performed and reported, as described below, by the authorized user or by other approved persons.

Surveys should be performed as needed to satisfactorily monitor the use program. One

shall be performed at least once every 3 months and the results shall be reported to the RSS on OA Form 41, "Radiation Survey Report" (appendix F, p. 54), available from the RSS.

**SECTION I OF OA FORM 41 SHALL BE COMPLETED BY ALL RADIOSOTOPE USERS OTHER THAN USERS OF SEALED SOURCES.** All radioisotope laboratories shall be monitored for radioactive contamination. The best method of monitoring for surface contamination will depend on the kinds of radioactive materials being used, their form, the types of surfaces, and so forth. Generally the best results will be obtained by taking wipe samples and analyzing them with appropriate instrumentation and/or surveying the surfaces or area with a portable survey instrument. In both cases, the instrumentation used shall have a detection system that is sufficiently sensitive to the radioactive material involved. The results of the survey shall be reported in columns C, D, E, and F in terms of actual readings obtained. Any reading exceeding three times normal background shall be considered unsatisfactory and decontamination procedures shall be effected. In section I-A the description of the instruments used shall include instrument normal background and the type of detector, if appropriate. Under column G an affirmative statement shall be made to certify that posting and labeling requirements are satisfied. All rooms and areas of radioisotope use shall be posted with standard CAUTION - RADIOACTIVE MATERIALS signs. All containers shall be labeled with CAUTION - RADIOACTIVE MATERIALS labels. A Form AEC-3 shall be posted in at least one conspicuous location in all facilities using byproduct material. Additionally, copies of 10 CFR 19, 10 CFR 20, and the appropriate license shall be retained on file for reference as needed.

**SECTION II SHALL BE COMPLETED BY ALL USERS OF SEALED SOURCES THAT ARE UTILIZED IN LABORATORY SETUPS AND OF RADIATION-EMANATING EQUIPMENT.** Under columns B, C, and D the actual readings in mR/h as obtained with an

appropriate survey instrument shall be recorded. The maximum reading at closest approach refers to closest approach by persons not involved with use of the equipment. The instruments used to monitor electron microscopes and X-ray equipment shall be responsive to low-energy X-rays. Under column E an affirmative statement shall be made to indicate such items have been checked and found to be operative. Under column F an affirmative statement shall be made certifying that posting and labeling requirements are satisfied. Posting and labeling for sealed sources is the same as specified previously for radioisotope use. For electron microscopes and X-ray equipment a CAUTION - RADIATION sign shall be posted on the door to the room or area, and a sign shall be affixed to the device specifying that it produces X-rays when energized.

5.19 *Contaminated Equipment.* Laboratory products and other equipment that cannot be decontaminated to a radiation level less than three times background at 1 inch shall be held and treated as waste.

5.20 *Contaminated Work Surfaces.* Any surfaces such as bench, floor, hood, or wall, showing a radiation dose rate greater than three times normal background at 1 inch shall be decontaminated to background level.

5.21 *Contaminated Clothing.* Clothing shall be monitored before entering laundering facilities. Any items giving radiation dose rates greater than three times normal background at 1 inch shall be reduced to this level by decontamination or decay before release for laundering.

5.22 *Spills and Decontamination.* All spills of radioactive material shall be cleaned up promptly to background level. Cleaning responsibility rests on the authorized user or the RPO, and a survey shall be made during and after cleaning to verify that the cleaning has removed the radioactive material. Cleaning implements shall be assigned to the room in which the work operations are being performed and *NOT* removed or used elsewhere. The techniques of cleaning and decontamination begin with soap and water and continue through the use of detergents, wetting agents, solvents, chemical solutions, and, in the case of contaminated equipment or laboratory surfaces, physical

removal such as stripping, scraping, grinding, and sand blasting. The use of disposable bag-type vacuum cleaners should be considered for decontamination jobs involving particulate matter that is likely to be soluble in water or other cleaning liquids. NCRP Report No. 8 recommends some of the other suitable techniques and agents for the removal of radioactive contamination. The RSO shall be notified of all spills or incidents involving possible contamination or if assistance is needed.

5.23 *Separate Counting Room.* If a separate counting room is used, the only radioactive materials in the room should be the prepared samples that are to be counted and the instrument standards.

5.24 *Animal Wastes.* Feces and urine from animals to which radioactive materials have been administered shall be collected, handled, and disposed of as radioactive waste. Sacrificed animals shall be stored in a freezer until they are disposed of. (See appendix G, p. 56, regarding disposition of meat from animals that have been exposed to radiation.)

5.25 *Unusual Handling Procedures.* Unusual procedures and particularly those utilizing special handling and/or administering equipment shall be rehearsed as a "dry run," that is, without radioactive material, to rectify technical errors and to assure reproducible safe procedures.

5.26 *Small Animal Experiments.* Small animals treated with radioactive material shall be handled with glove-protected hands and shall remain in their cages or experimental chambers until their excreta contains only background amounts of radioactive material or until they are sacrificed. The radioactive animals or their cages should be marked with labels indicating the kind and amount of radioisotope used, the date of administration, and name of user. Cages should be properly decontaminated by scrubbing with detergent before reuse. Adequate ventilation must be provided in instances where animals are kept after an injection with radioactive materials that may become volatilized and dispersed into the room at significant levels. Animal handlers must be indoctrinated by the responsible user as to dose levels, time limitations in the area, and the



handling requirements of the animals and excreta.

- 5.27 **Release of Radioisotope Laboratory for Unrestricted Use.** In the event a greenhouse, radioisotope laboratory, or that portion of a chemistry laboratory that has been used for radioisotope work is to be abandoned or released for unrestricted use, a thorough radiation survey shall be made by responsible user(s) or the RPO just prior to such abandonment or release as described in Section 5.18. This survey shall include measurement of all traps, drain lines, and ductwork. If appropriate, decontamination shall be effected as required. Survey results shall be submitted to the RSS on OA Form 41. All radiation warning signs, tags, and labels shall be removed. If the report is acceptable, the RSS will release the laboratory for unrestricted use.

## Section

- 6.0 **Rules and Requirements Concerning Field Experiments**
- 6.1 **General.** A "field experiment" is any experiment in which radioactive material is released into the biosphere; for example, release of tagged insects, use of labeled soil amendments, use of tagged seeds, and use of tracers in studies of ground water movement.
- 6.2 **USNRC Approval.** All field experiments involving large quantities of radioactive material require the *specific* approval of the USNRC as well as Committee approval. Application for such approval, either as a specific license or as an amendment to the Department's license, shall be made only by the RSO. Requests for Approval (see section 2.6, p. 2) for field experiments shall include the additional information listed below. The request for approval will thus be made a part of the application, which the RSO submits to the USNRC for approval.
- A. **Population.** A full description of the distribution of the human population and animal population in and near the experimental area.
- B. **Watershed.** A detailed statement of the relationship of the experimental area to watersheds from which domestic water supplies are collected, including a topographical map of the area. The proximity

of the experiment to such watersheds may constitute a hazard under the conditions of the experiment.

- C. **Geology.** All information available on the underground strata with reference to the likelihood of movement of water or the fixation of activity by mineral components.
- D. **Control.** A statement regarding the degree of control, both human and animal, that can and will be maintained over the area.
- 6.3 **Committee Approval.** In addition to the requirements of section 6.2 above, the Committee will require written confirmation that the following will be complied with before submitting its application to the USNRC.
- 6.4 **Field Experiments on Land Not Under Control of the USDA.** Whenever possible, field experiments should be carried out on land owned or controlled by a Department agency. If this is not possible, a written agreement shall be consummated between the agency and the landowner, except when portable radiation-emitting soil moisture or soil density equipment or portable X-ray equipment is used. The terms and conditions of the agreement should be prepared in accordance with the provisions of applicable agency administrative memoranda or directives governing such agreements. The written agreement and Request for Approval shall be submitted to the RSO simultaneously to insure that radiological safety matters specified in both documents are compatible and to receive Committee approval. The documents should be submitted and approved *before* the agreement is executed by the parties involved.
- 6.5 **Control of Persons.** Plans for the restriction of access to and the posting of the experimental area will be agreed upon by the authorized user and the Committee.
- 6.6 **Monitoring.** Monitoring and reporting requirements will be established by the Committee or RSO and stated in Notice of Action to authorized user. No field experiments shall be undertaken when conditions will not permit the authorized user to fully complete the monitoring report required.
- 6.7 **Crop and Waste.** The crop and/or waste from a

field experiment shall be removed or otherwise disposed of in accordance with procedures approved by the Committee or as specified in this handbook after the experiment is completed.

## Section

### 7.0 *Rules and Requirements Concerning Sealed Sources*

7.1 *General.* Several types of sealed sources are of interest to Department personnel. Specific rules for handling, monitoring, leak testing, storing, and reporting will be determined for each application by the Committee. Prior approval of the Committee is required for the procurement of all sealed sources regardless of whether or not such sources require USNRC license, except those furnished as check standards with radiation measuring or counting instrumentation. This section does not include requirements for *large multicurie sources* that must be used only in heavily shielded devices such as irradiators. Requests for such sources will be considered on an individual basis by the Committee and the prospective user will be advised accordingly.

7.2 *Request for Approval.* Notification of action by the Committee authorizing procurement or fabrication of a sealed source will be used upon favorable review of the prospective user's Request for Approval, which shall include the following:

- A. A brief statement of proposed use of the sealed source.
- B. Radioactive material and quantity of activity in millicuries required.
- C. Design details of source including method of sealing, or make, model, and serial number if a commercially available source is to be procured.
- D. If source will be used in shop-built device, details of device construction including materials used, means for mounting source or source holder, method of fabrication, and thickness of shielding.
- E. Description and length of handling tool that will be used, if appropriate.
- F. Sketch of laboratory or area showing location of source, adjacent rooms or areas, and occupancy factor of each room or area.

G. Operational procedures to be followed including monitoring.

H. A statement of the qualifications of the prospective user of the source. OA Form 30 (see appendix B, p.31) is available from the RSS for submitting this information.

I. Arrangements that have been made or will be made to have source leak tested. (See sections 7.8, 7.9, 7.10, and 7.11.)

J. Description of storage container for source and place in which it will be stored.

K. Disposition of source when experiment is completed, if appropriate.

L. Emergency procedures to be followed in event of accident.

7.3 *Source Tagging and Labeling.* Each sealed source that is not fastened to or contained in a device shall have permanently attached to it a durable tag at least 1 inch square bearing the standard radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions, CAUTION: RADIOACTIVE MATERIAL. DO NOT HANDLE. NOTIFY CIVIL AUTHORITIES IF FOUND.

7.4 *Radiation Warning Signs.* Check each room or area in which a sealed source is used and/or stored and post appropriate signs as follows:

- A. A CAUTION RADIATION AREA sign pursuant to Section 20.203 (b), 10-CFR-20.
- B. A CAUTION RADIOACTIVE MATERIAL sign pursuant to Section 20.203 (e), 10-CFR-20.
- C. A CAUTION RADIOACTIVE MATERIAL label on each container pursuant to Section 20.203 (f) (1), 10-CFR-20.
- D. A CAUTION RADIOACTIVE MATERIAL label on each storage container. This label shall also state the kind of radiomaterial, the quantity, and the date of measurement of the quantity.

7.5 *Storage Security.* Storage rooms or cabinets containing sealed sources and/or radiation-emitting equipment shall be kept locked at all times to prevent tampering or removal by unauthorized personnel. The place of storage



should be chosen so as to minimize risk from fire. Radiation level at closest approach to room shall not exceed one milliroentgen per hour.

- 7.6 *Instructions to Assistants.* Each technician or assistant using a sealed source under the direct personal supervision of an authorized user shall be thoroughly instructed in safe handling and operational procedures and be fully aware of all restrictions that are imposed. Such instructions shall be given prior to the initiation of work with the source. Independent use of sealed sources by assistants or technicians is not permitted without prior Committee approval.
- 7.7 *Miscellaneous Sealed Source Requirements.* Any of the actions listed below require approval of the Committee before they are effected.

- A. A major change in, or additional use of, the source from that originally approved.
- B. Transfer of source to a new location.
- C. Transfer of responsibility for source to a new user.
- D. Modification of device containing source.
- E. Replacement of source.
- F. Disposal of unwanted or surplus source (unless transferred to authorized recipient and properly reported on OA Form 3).
- G. Independent use of source by a marginally trained technician or assistant.
- H. Tagging of sealed source.
- I. Procurement and use of additional source or source containing different radioelement.

- 7.8 *Leak Testing of Sealed Sources.* Since most commercially available gamma-emitting sealed sources are required to be doubly encapsulated and sealed by welding or equivalent, normally there is no radioactive contamination or leaking problem associated with their use. However, if the source capsule should fail because of wear, corrosion, radiation damage, mechanical damage, or for other reasons, the radioactive material inside the capsule may escape and produce a hazard to those who come in contact with the material. Alpha and beta sources are particularly vulnerable to developing leaks in their coverings, that must be thin enough to allow penetration of the particles. Sealed source capsules *have* failed and for this reason the

Department's license and the Committee require that each sealed source containing radioactive material (except (1) those containing hydrogen 3 or gas, (2) those having a half-life less than 30 days, and (3) those containing 100 microcuries or less of beta- and/or gamma-emitting material or 10 microcuries or less of alpha-emitting material) shall be tested for leakage and/or contamination at intervals not to exceed 6 months. For pure alpha particle emitters the intervals between tests shall not exceed 3 months. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If sufficiently sensitive instrumentation is not available, the test sample may be sealed in thin plastic film or bag, properly identified, dated, and mailed to the RSS for measurement. Distributors of sealed sources generally supply with each source a certificate that indicates the results and date of the last leak test performed. A copy of this certificate may be submitted to the RSS and will be accepted as meeting the initial leak test requirement. If such a certificate is not received by the authorized user, the source shall *not* be put into use until a leak test has been performed and the acceptable results of the test have been received and submitted. Thereafter, the source shall be tested at intervals not to exceed 6 months. A Notice of Leak Testing will be sent to the authorized user about 3 weeks before the next leak test is due.

- 7.9 *Performance of Leak Tests.* The selection of a testing procedure to be used for a particular sealed source must be based on demonstrated efficiency in the removal of radioactive contamination from sources of this particular construction and material with special consideration of the radiological hazard to the person performing the test. Evidence must accompany the description of the test proposed to clearly establish that the test procedure has a sensitivity and accuracy that will permit detecting the contamination limit of 0.005 microcurie. The actual testing may be done by either of the following:

- A. The authorized user or one of his staff qualified by training and experience in radiochemical techniques may assume

responsibility for testing the sealed source. Under these circumstances, the prospective user's Request for Approval should include information as to the preferred leak testing procedure of those set forth under section 7.10, the frequency with which tests will be done, the instruments available for the purpose of properly measuring the leakage, and the training and experience in these techniques of the person to be responsible for performing the leak testing. If the authorized user does not have sufficiently sensitive instrumentation, he should contact the RSS for assistance.

- B. Contact with the supplier or qualified commercial firm for testing. In this case the Request for Approval shall include the name and pertinent experience of the firm selected unless such testing is a part of the procurement contract. Regardless of whether method "A" or "B" above is followed, prior approval of the Committee shall be obtained.

7.10 *Kinds of Leak Tests.* Numerous kinds of tests can be performed to determine whether or not a source is leaking. Four of the most common tests are described below. Of the four, the Committee recommends 7.10.1 as it can be readily and safely performed.

- 7.10.1 *Wipe Test.* If procedure can be accomplished safely, all exposed external surfaces are thoroughly wiped or "smeared" with a piece of filter paper, or other suitable material of high-wet strength and absorptive capacity, moistened with a solvent such as water, alcohol, or acetone that will not attack the material of which the source capsule or device is made and that under the conditions of this test has been demonstrated to be effective in removing the radioactive material involved. The paper or material is allowed to dry and its total activity is appropriately measured. A source that normally remains in its shield or device while used shall never be removed to perform a leak test. An acceptable leak test on such a source is to wipe the external surfaces of the shield or device on which contamination would most likely accumulate if the source were leaking. When the source is normally removed from its

shield for use, it should be wiped directly. In such case the source should be handled with an appropriate handling tool and never directly with the hands. The wipe is then dried and measured as described above.

- 7.10.2 *Scrub Test.* The object to be tested is immersed in a solution that will not attack the material of which the capsule or source holder is made and that has been demonstrated to be effective in removing the radioisotope involved when the object is scrubbed with a brush under the surface of the liquid. All surfaces of the object are brushed thoroughly under these conditions. The total radioactivity is measured in the residue obtained by the evaporation of the solution.

- 7.10.3 *Immersion Test.* The object to be tested is immersed in a solution that will not attack the material of which the capsule or source holder is made, and that has been demonstrated to be effective in removing the radioisotope involved. The solution is heated to  $50^{\circ} \pm 5^{\circ} \text{C}$  and held at this temperature for 8 hours. The total radioactivity is measured in the residue by evaporation of the solution.

- 7.10.4 *Cellulose Tape Test.* This test is applicable to a device containing a sealed source in a source holder that has an opening through which the radiation emerges. This opening or port is kept covered for a minimum of 7 days with a piece of thin adhesive cellulose tape. The tape is carefully removed with forceps and the radioactivity that may have been deposited on its adhesive side is measured with appropriate instrumentation.

- 7.11 *Leak Test Results and Reports.* If the approved test reveals the presence of more than 0.005 microcurie of alpha, beta, or gamma radioactivity, the sealed source shall be immediately removed from use for rechecking, repair, or disposal. The RSO shall be notified immediately by telephone. The results of the test shall be recorded on OA Form 42, "Sealed Source Leak Test Report," and submitted to the RSO within 1 week after the test. (See appendix H, p. 57) OA Form 42 will be furnished the authorized user by the RSO at time Notice of Action is issued, Notice of Leak Testing is sent, or upon request.



## 7.12 *Special Requirements of Neutron Soil Moisture and Soil Density Gages Containing Sealed Sources.*

7.12.1 *General.* A neutron soil moisture gage customarily contains either a  $^{226}\text{Ra}$  Be or  $^{241}\text{Am}$  Be sealed neutron source, the latter emitting a greater neutron flux. A soil density gage customarily contains either a  $^{226}\text{Ra}$  or  $^{137}\text{Cs}$  sealed source that emits gamma rays. A surface moisture-density gage contains a combination  $^{137}\text{Cs}$ - $^{241}\text{Am}$  Be sealed source. The maximum radiation from such sources when they are in their shielded position in the gage is about 50 milliroentgens per hour at the surface of the gage. Since these sources produce neutron and gamma fields, which at 1 or 2 feet exceed the maximum permissible exposure levels (2.5 milliroentgens per hour as specified in 10-CFR-20), special requirements as set forth below must be met in addition to those specified for sealed sources in sections 7.0-7.11. Further, some Regional Offices in the Forest Service have prepared and issued safety procedures for nuclear moisture-density gages. These procedures have been approved by the Committee and should be followed by appropriate personnel in the Forest Service.

### 7.12.2 *Training and Experience Requirements*

- A. The authorized user shall have knowledge of the descriptive literature and operating instructions furnished by the manufacturer of the gage.
- B. The authorized user shall have knowledge of radiation hazards associated with the gage.
- C. The authorized user shall have knowledge of the requirements specified in this handbook.
- D. The authorized user shall have at least 16 hours field use of the gage under the direct personal supervision of a Committee-approved user or the manufacturer's technical representative, or equivalent training and experience as determined by the Committee.

### 7.12.3 *Request for Approval Requirements*

- A. A statement describing the major use of the gage; for example, to follow the effect of tillage practice on moisture movement in, or density of, soil.

- B. The anticipated schedule of use; for example, daily measurements on 72 sites or weekly readings at four depths on 100 sites.
- C. The radioactive material and quantity of activity in each source.
- D. The names of all personnel who will use the gage and the name of the individual who will be responsible for safe use, transport, storage, leak testing, film badges, and preparation of records.
- E. Training and experience of each individual who is to become an authorized user. This information shall be submitted on OA Form 30 available from the RSS. (See appendix B, p. 31.)

### 7.12.4 *Radiological Safety Requirements*

- A. Each person participating in the use of a gage shall wear a film badge at his waist.
- B. Operator shall use gage as expediently as possible pursuant to instructions without compromising radiological safety.
- C. The responsible user shall maintain a daily use log for each operator that shall include the following entries and be available to the RSO, upon request (1) name of operator, (2) date(s) of use, (3) hours of use, (4) type of use, that is, calibration, routine measurement, leak testing, and so forth, and (5) film badge identification number.
- D. When transporting gage to field site, it shall be in its carrying case, placed as far as possible from occupants of vehicle, and be protected from shock. Department of Transportation regulations require that the outside of the vehicle shall be placarded on the front, back, and each with a sign reading RADIOACTIVE if the radiation dose rate at the surface of the carrying case exceeds 10 milliroentgens per hour. The placards shall be printed with black letters 4 inches high and 5/8-inch stroke on a durable material having a yellow background that extends at least 1 inch on all sides of the lettering. Placarding can be avoided if the gage is so packaged that the dose rate at the surface of the package will not exceed 10 milliroentgens per hour. Vehicle containing

- gage shall be locked when the user is not in attendance.
- E. Hands shall not be placed on gage when the source is in unshielded position.
  - F. Source shall not be placed in an unshielded position when gage is not being used for its intended purpose.
  - G. Source or shield shall not be tampered with.
  - H. Source shall be returned to shielded position when not in use.
  - I. If gage has been damaged to the extent where the source or shielding has been severely damaged, notify responsible user who shall notify the RSO for guidance. Do not touch or move gage. Keep all personnel away from gage a distance of at least 10 feet.
  - J. The gage shall be stored in a locked room where radiation level at closest approach shall not exceed one milliroentgen per hour. Door to room shall be posted with a standard sign reading CAUTION: RADIOACTIVE MATERIAL.
  - K. If gage has been lost or stolen, immediately notify responsible user who shall notify RSO for guidance.
  - L. The source in the gage shall be tested for leakage and/or contamination upon receipt and thereafter at intervals not to exceed 6 months in accordance with procedures described in section 7.8 and following.
  - M. Surplus gages that, owing to lack of takers after appropriate advertising, cannot be transferred to another laboratory or station pursuant to procedures specified in this handbook shall be disposed of by transfer to the supplier or to a licensed commercial waste disposal firm (see section 3.4.8, p. 5.)
  - N. When authorized users have a thorough knowledge of a nuclear gage, its operating principles, and purpose and method of operation, and comply with the safety requirements specified in this handbook, the Committee considers the gage almost harmless and the purchase of a costly instrument for monitoring gamma rays or neutrons optional. This is further justified

by reviews of many radiation exposure reports that have indicated substantially no overexposures to personnel. Should a reversal of this become apparent, however, the Committee will require authorized users to purchase and use an appropriate instrument. If such instrumentation is readily available (as from a university health physics office, civil defense organization, hospital radiology department, or radioisotope laboratory) the Committee recommends its loan and use to apprise users of radiation levels that do exist around the gage.

#### 7.13 *Special Requirements for Civil Defense Preparedness Agency Cobalt 60 Sealed Source Sets*

7.13.1 *General.* The possession and use of  $^{60}\text{Co}$  sources as supplied by the Defense Civil Preparedness Agency (DCPA) for training radiological monitors by Department personnel is covered by a license issued to the Department by the USNRC and is under the jurisdiction of the Committee. The Department has discontinued to possess its own source sets because they are available and may be borrowed from many licensed individuals or State or local civil defense organizations outside the Department. In any case, however, a Letter of Authorization for the possession and use of a source set for training purposes must be obtained from the Committee before the set is acquired. The special requirements listed below shall also be met.

#### 7.13.2 *Training and Experience Requirements*

- A. Only those USDA employees who have satisfactorily completed a DCPA Radiological Monitoring for Instructors Course (32 hours), an ARS Training Course for Instructors, or have equivalent nuclear training as determined by the Committee will be granted authority to possess and use a source set by the Committee.
- B. Authorized users of  $^{60}\text{Co}$  sealed source sets shall be versed in the contents of the publication entitled "Procedures and Regulations for the Care and Use of the OCD CD V-778 Radiation Training Source Set" (TM-67-1) prepared by and available from the Defense Civil Preparedness Agency, Attention: PO(Detection



and Countermeasures), Washington, D.C. 20301. This publication contains such information as listing of equipment in kits; preparation and activity of sources; USNRC and DCPA rules and regulations governing the receipt, use, storage, and transfer of sets; and instructions for the replacement of rings and warning tags on sources and for leak testing sources. Since this publication is revised as necessary, it is the responsibility of the authorized user to obtain and follow requirements specified in the latest issue.

#### 7.13.3 *Request for Approval Requirement*

Application for the authorization discussed above shall be made by the qualified user in a memorandum to the RSS. If internal administrative procedures require coordination, the memorandum should be channeled through appropriate agency supervisors for action and submission to the RSO for issuance of Letter of Authorization.

#### 7.13.4 *Radiological Safety Requirements*

- A. Monitoring and reporting requirements as specified in letter of authorization from RSO shall be effected.
- B. Each DCPA sealed source to be used outside of a shielded exposure device shall have a durable, legible, and visible tag permanently attached to the source. The tag shall be at least 1 inch square, shall bear the conventional radiation symbol, and a minimum of the following instructions: DANGER - RADIOACTIVE MATERIAL - DO NOT HANDLE - NOTIFY CIVIL AUTHORITIES IF FOUND.
- C. Sources shall never be left unattended and shall be placed into storage container by authorized user upon completion of training exercise.
- D. Cobalt 60 source sets borrowed from authorized individuals or organizations shall be returned as soon as possible after the training session is completed.

7.13.5 *Cancellation of Letter of Authorization.* An authorized user holding a valid letter of authorization who does not plan to use a  $^{60}\text{Co}$  source set for radiological training purposes due to changes in program objectives, retirement, or

other reasons should request cancellation of his letter of authorization by writing to the RSO, Beltsville, Md.

#### 7.14 *Special Requirements and Privileges for Radioactive Sources in Gas Chromatographs (GC)*

7.14.1 *General.* Some GC are equipped with electron capture detectors that contain radioactive sources (foils) of  $^3\text{H}$ ,  $^{90}\text{Sr}$ ,  $^{63}\text{Ni}$ , or  $^{226}\text{Ra}$ . Procedures for procuring and using such sources are similar to those for standard sealed sources (see sections 7.1, 7.2, 7.4, 7.5, 7.8, 7.9, 7.10.1, and 7.11). However, the following additional special requirements shall be met.

#### 7.14.2 *Radiological Safety Requirements*

- A. The part of the GC containing the detector shall be vented directly to the atmosphere or to an operating hood to prevent radioactive off-gases from entering the laboratory.
- B. The GC shall not be operated above recommended temperature for electron capture detector.
- C. Prior Committee approval shall be obtained if authorized user desires to replace or to clean corroded foil himself. In such case the request to the Committee shall contain (1) replacement and cleaning procedures, including handling and radiation safety procedures to be followed, (2) experience of user in replacing or cleaning foils, and (3) method of disposal of replaced foil or contaminated cleaning materials.

#### 7.14.3 *Privileges Associated With GC Authority*

The initial authority to procure and use a GC detector containing a radioactive source includes the privilege, without obtaining further Committee approval, for the authorized user to:

- A. Procure and use a similar replacement detector. In such cases, the purchase order for the replacement detector or correspondence to the RSS shall indicate the serial number of the *old* detector and the purchase order number under which it was obtained. An OA Form 3 shall be completed and submitted for the *old* detector when it is properly disposed of.
- B. Have a detector repaired and/or refurbished provided the work is performed by

a supplier. In such case, the purchase order or correspondence shall identify the detector by serial number. An OA Form 3 need *not* be completed and submitted. However, if the amount of activity in the refurbished detector has been changed, the RSS shall be advised so that records can be changed accordingly.

- C. Procure and install replacement foils provided he has obtained prior Committee approval for this procedure. An OA Form 3 shall be completed and submitted when the replaced foils are disposed of.

It is emphasized that in each of the above cases the original and two copies of the purchase order shall be submitted to the RSS for processing. Appropriate forms will be supplied to the authorized user at that time. It is further emphasized that whenever *additional* radioactive detectors are needed, the authorized user shall obtain Committee approval *before* procurement action is initiated.

- 7.14.4 **Leak Testing Requirements.** Detectors containing radioactive materials, except those containing  $^3\text{H}$  or  $^{226}\text{Ra}$ , shall be tested for leakage and/or contamination at intervals not to exceed 6 months. An acceptable leak test is to wipe the external surface of the detector and the off-gas outlet. Leak test procedures specified in sections 7.8, 7.9, 7.10.1, and 7.11 shall be followed.

## Section

### 8.0 *Rules and Requirements Concerning X-ray Machines Up to 110 KVP*

- 8.1 **General.** The use of X-ray machines throughout the Department has increased sufficiently to justify a separate section which specifies the Committee requirements for their acquisition and safe use. However, since most Requests for Approval are for low-energy X-ray machines that operate at voltages not exceeding 110 KVP, the requirements stated apply only to such units. The installation and operation of X-ray machines must be such as to provide adequate protection for both operating personnel and any individuals in the vicinity of the machine.

### 8.2 *Training and Experience Requirements*

- A. The authorized user should preferably be a professional and shall have thorough

knowledge of operating instructions furnished by the X-ray machine manufacturer.

- B. The authorized user shall have knowledge of radiation hazards associated with the X-ray machine.
- C. The authorized user shall have operated the X-ray machine under supervision of a qualified user or manufacturer's representative, or he shall have had previous training or experience in the use of X-ray machines.
- D. The authorized user shall have knowledge of procurement and radiation safety requirements specified in the handbook.

## 8.3

### *Request for Approval Requirements*

- A. A statement describing the purpose(s) for which the X-ray machine will be used.
- B. The make, model number, and brief description of the X-ray machine to be procured. Manufacturer's descriptive literature should be furnished if available.
- C. A sketch showing where the X-ray machine will be located and the location of offices and personnel adjacent to the X-ray machine.
- D. Name of person who will be responsible for health and safety matters associated with the X-ray machine and names of persons who will operate the machine.
- E. A statement of the training and experience in radiation of each user. This information may be submitted on an OA Form 30 available from the RSS (see appendix B, p. 31).
- F. If field use is planned, identification of locations in which the X-ray machine will be used and how the unit will be positioned and used.

## 8.4

### *Radiological Safety Requirements*

- A. **Laboratory Use**
  1. Only Committee authorized personnel shall independently operate the X-ray machine.
  2. The X-ray machine shall be operated in accordance with instructions and precautions furnished by the manufacturer.
  3. The operator shall wear a film badge when using the X-ray machine (section 4.4, p. 6).
  4. The operator shall be responsible for the



health and safety of persons in and around the X-ray room or area when the machine is in operation.

5. The X-ray machine shall be placed away from heavily trafficked areas with suitable restrictions against unauthorized access.
6. If the room in which the X-ray machine is located has a room beneath it, appropriate shielding shall be placed directly beneath the tube head and shall be of sufficient width, length, and thickness to attenuate the useful beam.
7. Whenever possible, the X-ray machine shall be used in a shielded cabinet or within portable protective shields. The cabinet shall be equipped with interlocks that will turn the machine off when its door is opened.
8. The tube head shall be directed primarily in a downward direction when specimens are radiographed.
9. The best voltage, milliamperage, filter, and cone combination shall be used to minimize both direct and scatter radiation.
10. An automatic timer shall be provided that will permit accurate presetting and determination of exposure as short as 1 second.
11. The operator shall stand as far as possible from tube head during the exposure.
12. Tests and inspections of all safety devices shall be performed frequently to insure their proper operation.
13. The X-ray tube shall not be operated if shielding on the tube head has been removed for any reason.
14. With analytical X-ray equipment, unused tube head ports shall be secured in closed position; fingers, hands, and wrists shall not be placed into the primary beam; and appropriate safety precautions shall be observed when aligning or adjusting the unit.
15. Warning lights that light whenever the tube is delivering X-rays shall be placed at the tube on-off switches and at sample holders. The installation of the lights should be "fail-safe" or two lights shall be

installed in parallel to provide a warning even if one bulb burns out.

16. A quarterly radiation survey shall be made with a suitable survey instrument on the machine and in areas around the X-ray machine when it is operating at its maximum rated voltage and amperage and a report shall be submitted to the RSS.
17. The X-ray machine shall have a conspicuous label thereon reading CAUTION X-RAYS - THIS EQUIPMENT PRODUCES X-RAYS WHEN ENERGIZED, or equivalent.
18. The entrance to room or area containing the X-ray machine shall be posted with a sign reading CAUTION - RADIATION, or equivalent.

#### B. *Field Use*

1. The tube head shall be directed only in a downward direction or away from the operator.
2. The X-ray machine shall not be left unattended when operating.
3. The operator shall make certain that the area in which the X-ray machine is used is under his constant surveillance in that persons cannot enter the area when the machine is in operation. This will eliminate the need for setting up a fence, rope, chain, or equivalent barrier.
4. Applicable requirements specified under "A" above shall also be complied with.

8.5 *High-Energy Machines.* High-energy X-ray machines, particle accelerators, neutron generators, and so forth that require specially shielded containers and/or rooms, interlocks, warning devices, and so forth will be considered on an individual basis. The RSO should be contacted for procedures and requirements.

#### 9.0 *Rules and Requirements Concerning Electron Microscopes (EM)*

9.1 *General.* Radiation surveys of various types of electron microscopes revealed that many are a potential source of X-ray exposure due to such factors as (1) improper operational practices, (2) physical deficiencies, (3) whiskered filaments, and (4) changes resulting from servicing, cleaning, and movement of unit. To protect personnel involved with EM, the Committee has

determined that uniform radiation safety requirements will be applied to all EM.

#### 9.2 *Training and Experience Requirements*

- A. The authorized user should preferably be a professional and shall have thorough knowledge of operating instructions furnished by the EM manufacturer.
- B. The authorized user shall have knowledge of potential radiation hazards associated with EM.
- C. The authorized user shall have operated the EM under supervision of a qualified user, or the manufacturer's representative, or he shall have had training and experience in use of EM.
- D. The authorized user shall have knowledge of procurement and radiation safety requirements specified in this handbook.

#### 9.3 *Request for Approval Requirements*

- A. A statement of the purpose(s) for which the EM will be used.
- B. The make, model number, and brief description of the EM to be procured. Manufacturer's descriptive literature should be furnished if available.
- C. A sketch showing where the EM will be located.
- D. A statement of the training and experience of the responsible user of the EM. This information may be submitted on OA Form 30 available from the RSS (appendix B, p. 31).

#### 9.4 *Radiation Safety Requirements*

- A. All EM components shall be of proper design and in working condition at all times.
- B. Only trained personnel shall operate the EM in accordance with instructions furnished by the manufacturer.
- C. Operators of EM shall wear film badges. Film badge service will be initiated by furnishing name, birthdate, and social security number of each EM user to RSS, Beltsville, Md.
- D. The room containing the EM shall be a controlled area to which only authorized personnel have access and shall be posted with a clearly visible sign reading CAUTION - RADIATION, or equivalent.

E. The EM shall be labeled with a conspicuous label reading CAUTION - THIS EQUIPMENT PRODUCES X-RAYS WHEN ENERGIZED, or equivalent.

F. Operating at maximum kilovolt potential and current, the EM shall be surveyed with an appropriate instrument (1) whenever the filament is changed or unit is modified, (2) after EM is serviced, cleaned, or moved, or (3) at intervals not to exceed 3 months. An EM whose survey shows a reading of 0.5m R/h or greater, when measured at 2 inches from any external surface, shall not be used until the radiation has been reduced preferably to background.

G. Responsible user shall report survey results and, if applicable, corrective action taken to the RSS.

### Section

#### 10.0 *Rules and Requirements Concerning Emergencies*

10.1 *General.* The extent to which emergency procedures are applied in the event of an accident involving ionizing radiation depends on the type and seriousness of the accident. Accordingly, since it is extremely difficult to specify emergency procedures that will cover all situations, listed below are the primary emergency procedures that shall be followed immediately to insure safety of personnel and minimum loss of property. Specific emergency procedures covering extremely hazardous radiation-emanating equipment or large quantities of radioactive material will be furnished by the RSO at the time approval for such equipment or large quantities is granted.

#### 10.2 *Primary Emergency Procedures*

- A. The responsible user shall promptly notify his supervisor; the RSO, Beltsville, Md.; and security personnel if needed.
- B. Personnel shall be evacuated from room or area and others kept away.
- C. Personnel shall be monitored before they become dispersed and shall change clothes as necessary.
- D. In case of radioactive spill, responsible user shall confine spill by placing

absorbent material thereon and quarantine room or area. In case of aerosol release or explosion, all ventilation shall be turned off and doors and windows shall be taped shut and no access permitted until respirator-equipped decontamination team enters.

- E. In case of malfunction of radiation-emanating equipment, responsible user shall quickly turn off equipment if possible and keep persons away until radiation survey determines extent of hazard and corrective action to be taken.
- F. In case of fire, responsible user shall call fire department whose fire-fighting actions shall be governed by the authorized user's or RPO's assessment of hazard. Stay out of smoke, dust, or mists. Spread of contamination shall be minimized as much as possible.
- G. If minor wounds occur or radioactive material enters eyes or is deposited on skin, promptly wash wounds, eyes, or skin with copious amounts of running water and soap if possible and report to employee health office.
- H. In case of known or suspected internal or external radiation overexposure, notify RSO immediately for guidance and referral to competent medical authority if warranted.
- I. Authorized user, supervisor, or RPO shall promptly investigate cause of accident and obtain and record pertinent information necessary to prepare accurate accident report, which may be needed by RSO for submission to appropriate authorities and for record purposes.
- J. Under guidance of RSO, prepare and implement corrective procedures that will prevent recurrence of a similar accident in the future.
- K. Loss or theft of radioactive material and/or radiation-emanating equipment

shall be reported by telephone to supervisor and to RSO immediately after its occurrence becomes known.

## Section

### 11.0

#### *Reference Material*

### 11.1

*Federal Regulations.* A license for the use of radioactive material in the licensing jurisdiction of the USNRC requires that the license comply with the rules and regulations issued to date that are found in the Code of Federal Regulations, Title 10, Parts 19, 20, 30, 31, 33, and 36. Part 20, "Standards for Protection Against Radiation," is included as appendix D and Part 19 as appendix K.

Pertinent excerpts from the regulations of the Department of Agriculture that are applicable to certain provisions of these rules are included as appendix G.

Questions regarding applicable regulations of the U.S. Department of Transportation, U.S. Postal Service, U.S. Coast Guard, Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, USNRC, and various State regulations should be directed to the RSS.

### 11.2

#### *National Council on Radiation Protection (NCRP).*

Recommendations of the NCRP are found in reports, pertinent issues of which are listed in appendix J. Though these reports contain valuable information that can be used as a guide, under the terms of the licenses granted by the USNRC, all Department operations must conform to the Federal Register regulations and to the requirements of this handbook.

### 11.3

*Selected Bibliography.* Helpful material, with emphasis on radiation safety, will be found in publications and reports listed in appendix J. Since the selected list is not intended to be complete, the reader may refer to the bibliographies listed in these publications and reports and inquire at libraries for additional texts and periodicals in accordance with his interests and needs.



## LIST OF APPENDIXES

<i>Appendix</i>	<i>Title</i>	<i>Page</i>
A	Administrative Memorandum, AM 124.1, Radiological Safety Material and/or Radiation-Emanating Equipment .....	25
B	OA Form 30, Education and Radiation Training and Experience Report .....	31
C	OA Form 2, Report of Receipt of Radioactive Materials .....	33
D	Title 10, Part 20, Standards for Protection Against Radiation .....	34
E	OA Form 3, Radioactive Waste Disposal Report .....	52
F	OA Form 41, Radioisotope Laboratory Survey Report .....	53
G	9-CFR-Chapter III, Animal and Animal Products .....	55
H	OA Form 42, Sealed Source Leak Test Report .....	56
I	OA Form 4, Unassigned Film Badge Use Report .....	57
J	Selected Bibliography .....	58
K	10-CFR-Chapter 1, Part 19, Notices, Instructions and Reports to Workers; Inspections .....	59

## APPENDIX A

U. S. DEPARTMENT OF AGRICULTURE  
 AGRICULTURAL RESEARCH SERVICE  
 WASHINGTON, D.C.

AM 124.1

7/5/74

# ADMINISTRATIVE MEMORANDUM

## Radiological Safety and Procurement of Radioactive Material and/or Radiation-Emanating Equipment

### I PURPOSE

This AM outlines responsibilities and functions of the Radiological Safety Committee and the Radiological Safety Officer and Staff, sets forth prior approval requirements which must be followed by all persons planning to acquire and use radioactive materials and/or radiation-emanating equipment, and specifies procedures for procuring such materials and/or equipment. This revision combines the two AM's being cancelled and reflects the current organization.

AM 124.1 (11/22/68) and AM 210.14 (11/22/68) are cancelled. Changes are not starred.

### II DEFINITIONS

A Radioactive Material. Radioisotopes, neutron sources, or any other sources whether sealed or unsealed, which naturally or as a result of artificial inducement spontaneously emit radioactive particles or rays.

B Radiation-Emanating Equipment. Irradiators, nuclear moisture-density measurement gauges, static elimination devices, electron microscopes, x-ray machines, and other equipment or devices which are capable of emitting ionizing radiation.

C Committee. The Radiological Safety Committee.

<b>DISTRIBUTION:</b> Headquarters, Regions, Areas, and Locations	<b>ORIGINATING OFFICE:</b> Radiological Safety Staff
---	---

## Appendix A—Continued

## III GENERAL

Radioactive material and radiation-emanating equipment present a potential health hazard. Therefore, to protect personnel and the Department it is essential that the use of radioactive material or radiation-emanating equipment be effectively controlled to minimize the risks of contamination and/or exposure. The Agricultural Research Service is assigned responsibility for all administrative functions on behalf of the Secretary relating to radiological safety within all agencies of the Department. A Radiological Safety Committee appointed by and responsible to the Administrator, ARS, has been established to effect the safe use of radioactive materials and radiation-emanating equipment by Department personnel.

## IV RADIOLOGICAL SAFETY COMMITTEE

A Responsibilities. The Radiological Safety Committee develops, implements, and is responsible for such rules, procedures, instructions, and other measures as may be necessary to control the acquisition, use, and disposition, from the standpoint of radiation safety, of all radioactive material and radiation-emanating equipment.

B Membership. The Committee is composed of one or more representatives from among agencies using radioactive material and/or radiation-emanating equipment, who are trained or experienced in the safe use of such material and/or equipment, and a representative of management from the Office of Administrator.

The Chairman, a Radiological Safety Officer, and other members of the Committee are appointed by the Administrator to serve until their successors are named.

The Assistant to the Administrator, Legislation and Special Assignments (ARS Committee Management Officer), has on file the current membership and the name of the Committee Secretary.

C Functions.

1 Review requests for approval to use radioactive material and radiation-emanating equipment and approve or disapprove such requests from the standpoint of radiological safety.

2 Prescribe general rules, procedures, facility, and equipment requirements for the safe use of radioactive material and radiation-emanating equipment, including such special conditions as physical examinations, training, disposal of radioactive waste material, etc.



## Appendix A—Continued

AM 124.1  
7/5/74

3 Review, prior to issuance, such instructions concerning radiological safety as are prepared by agencies of the Department.

4 Review reports of the Radiological Safety Officer, including reports of inspections made, and make such recommendations thereon as may be necessary to the Administrator, heads of other Department agencies, or other officials.

5 Provide advice and assistance on radiological safety to agencies using or contemplating the use of radioactive material and/or radiation-emanating equipment.

6 Recommend disciplinary action when any person using radioactive material or radiation-emanating equipment fails to observe prescribed safety rules, procedures, and regulations.

D Meetings. The Committee shall meet as frequently as required by circumstances, but not less than once every six months. Attendance of other appropriate persons for a specific meeting may be requested by the Chairman.

V RADIOLOGICAL SAFETY OFFICER (RSO)

A Responsibilities. The Radiological Safety Officer is responsible to the Committee for administering on a day-to-day basis the rules, procedures, and instructions developed by the Committee and as required by licenses for the safe acquisition, use, and disposal of radioactive materials and/or radiation-emanating equipment and directs the Radiological Safety Staff.

B Functions of Radiological Safety Staff (RSS).

1 Serve as contact with Department agencies on all matters requiring approval of the Committee and provide information and instructions relative to requirements for such approval.

2 Within the framework of general rules, regulations, and procedures established by the Committee, prescribe specific radiological safety measures, rules, and procedures as necessary for various uses of radioactive material and radiation-emanating equipment including radiation monitoring and reporting schedules.

3 Maintain records of the purchase, receipt, use, transfer, and disposal of radioactive material; the location and use of radiation-emanating equipment; requests for approval to use radioactive material and radiation-emanating equipment and Committee action thereon; and other communications, transactions, and reports pertaining to the use of radioactive material and radiation-emanating equipment.

## Appendix A—Continued

4 Conduct regular safety inspections of radiation-emanating equipment and of means, methods, and facilities for handling, use, storage, and disposal of radioactive material and radiation-emanating equipment.

5 Prepare such reports to the Committee and the Atomic Energy Commission as may be required. Prepare such correspondence and applications to the Atomic Energy Commission as may be required to obtain additional byproduct material licenses or appropriate amendments to existing licenses.

6 Maintain close liaison with agency safety officials.

7 Provide advice and assistance on radiological safety problems to agencies using or contemplating the use of radioactive material and/or radiation-emanating equipment.

8 Stay abreast of current regulations published in the Federal Register which affect proper possession, use, storage, disposal, and transport of radioactive materials and appropriately apply new regulations to Committee's rules, procedures, and instructions and to license conditions.

#### VI PRIOR APPROVAL REQUIREMENTS

A Acquisition. The acquisition of radioactive material and/or radiation-emanating equipment by purchase or any other means is prohibited without prior approval of the Committee.

B Use. Radioactive material and radiation-emanating equipment shall be used only by authorized individuals for the purposes approved and in accordance with the rules and procedures prescribed by the Committee and/or Radiological Safety Officer. All experiments or other activities conducted in the open field, as opposed to those carried out within a laboratory or other housing facility, shall be carried out on land owned by or under the immediate control of USDA, except that land other than that owned or controlled by USDA may be used provided an appropriate agreement as specified by the Committee is concluded by USDA and the landowner.

C Disposition. Transfer, exchange, or other disposition of radioactive material and/or radiation-emanating equipment to other persons shall not be made without prior approval of the Committee.

D Cooperative Work Projects. Where cooperative work projects involving the use of radioactive material and/or radiation-emanating equipment are carried out under the supervision of other than a Department agency, no employee of USDA may participate in the work of such projects without prior approval of the Committee.

## Appendix A—Continued

AM 124.1  
7/5/74

## VII REQUESTS FOR APPROVAL

A Contents. Any person planning to undertake work involving the use of radioactive material and/or radiation-emanating equipment in any way must prepare and submit to the Radiological Safety Staff, USDA, BARC-West, Beltsville, Maryland 20705, a memorandum containing information listed below. This memorandum, prepared by the prospective user of the above-cited material or equipment, must be submitted and a reply must be received before any purchasing or other acquisition action is initiated.

1 A brief statement of the objective of the undertaking.

2 A description of the facilities to be used including details of laboratory, greenhouse, and/or field facilities and equipment. Where applicable, include description of the equipment to be used for handling; instrumentation to be used for monitoring, surveying, and assaying; facilities for storage; and method of waste disposal.

3 A detailed description of the plan of work when radioactive material is involved, including assay procedures to be used if applicable.

4 A statement of the prospective user's qualifications to safely handle, use and measure radioactive materials and/or radiation-emanating equipment. OA Form 30, Education and Radiation Training and Experience Report, is available from the RSS and should be used for submitting this information.

5 Where a radioactive material is to be used, a statement regarding the desired chemical form(s) and an estimate of the maximum amount of each isotope that will be on hand at any one time.

B Follow-up. The RSS will contact the prospective user if additional information is needed, or to explain specific requirements necessary to be satisfied prior to action by the Committee. Following this, the RSS will request Committee action.

C Notice of Action. Written notification of action by the Committee will be from the RSS to the user. This notice will include a Radiological Safety Committee Identification Number (e.g., RSC-21-1), which shall appear on all requisitions and purchase documents and such special instructions and forms as may be necessary. The notice shall be used by the user as authority, from the standpoint of radiological safety, to request procurement action for the approved radioactive material and/or radiation-emanating equipment.



## Appendix A—Continued

## VIII RULES FOR USE OF RADIOACTIVE MATERIAL AND/OR RADIATION-EMANATING EQUIPMENT

Concurrently with the Notice of Action sent to the responsible user, the RSS will forward all necessary rules, procedures, and instructions that must be adhered to in using the particular radioactive material and/or radiation-emanating equipment.

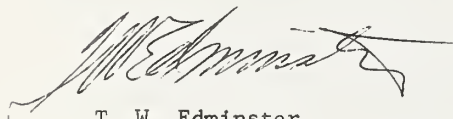
## IX ACQUISITION OF RADIOACTIVE MATERIAL AND/OR RADIATION-EMANATING EQUIPMENT

A Standard Form 44 (U.S. Government Purchase Order-Invoice-Voucher) or imprest funds shall not be used for purchase of radioactive material or radiation-emanating equipment.

B The original (supplier copy) and two copies of the purchase order (AD-38), or other purchase document, shall be submitted directly to the Radiological Safety Staff (RSS). This shall be done even for those small amounts usually referred to as exempt quantities. The supplier copy will be forwarded promptly, if in order, by the RSS and the user will be notified. When the supplier is the Oak Ridge National Laboratory (or other Atomic Energy Commission contractor) an AEC Form 375, Radioisotope Order Blank, shall be used as the original purchase document. This form signed by the appropriate procurement agent along with two copies of the purchase order, or other purchase document, shall be forwarded to the RSS.

C Requisitions and purchase documents shall contain the following statement: "Radiological Safety Committee Identification Number (enter number), Radioactive Material (or Radiation-Emanating Equipment) for (name of authorized user)."

D Where radioactive materials are to be furnished gratis, the RSS must be advised of the element, quantity of material, and supplier. The RSS will advise the supplier of any limitations imposed, the covering license, and appropriate related information.



T. W. Edminster  
Administrator

## APPENDIX B

U. S. DEPARTMENT OF AGRICULTURE  
AGRICULTURAL RESEARCH SERVICE

## EDUCATION AND RADIATION TRAINING AND EXPERIENCE REPORT

**NOTICE:** Pursuant to Department rules and Federal regulations the information requested herein is essential to the Radiological Safety Committee for approving proposals involving the use of radioisotopes and/or radiation equipment. This form is to be completed by each individual using, or contemplating the use of, ionizing radiation. Use supplementary sheets, where necessary; in such cases identify each item by number and sign each sheet. Mail one completed form to USDA, Plant Industry Station, Beltsville, Maryland 20705, Attention: Radiological Safety Officer. *Please write clearly, print or type.*

1. NAME AND HOME ADDRESS OF USER										2. NAME AND ADDRESS OF EMPLOYING OFFICE									
3. BIRTH DATE					4. SOC. SEC. NO.														

## 5. EDUCATION (Check appropriate squares)

ELEMENTARY SCHOOL								HIGH SCHOOL				UNIVERSITY								DEGREES EARNED			
1	2	3	4	5	6	7	8	1	2	3	4	1	2	3	4	5	6	7	8	BS	MS	PhD	OTHER (Specify)

6. EDUCATIONAL MAJOR OR SPECIALTY (Agricultural Engineering, Plant Physiology, Entomology, Chemistry, Physics, etc.)

## 7. RADIATION TRAINING COURSES COMPLETED (Academic and special)

TITLE OF COURSE	WHERE COMPLETED	DURATION (Weeks)	ON JOB TRAINING		FORMAL COURSE	
			YES	NO	YES	NO
A.						

DESCRIPTION OF COURSE (Briefly state subject matter covered which is pertinent to use of ionizing radiation)

B.					
----	--	--	--	--	--

DESCRIPTION OF COURSE (Briefly state subject matter covered which is pertinent to use of ionizing radiation)

C.					
----	--	--	--	--	--

DESCRIPTION OF COURSE (Briefly state subject matter covered which is pertinent to use of ionizing radiation)

D.					
----	--	--	--	--	--

DESCRIPTION OF COURSE (Briefly state subject matter covered which is pertinent to use of ionizing radiation)

EQUIPMENT AND/OR RADIOISOTOPES USED	MAXIMUM KVP OR AMOUNT IN MILLICURIES	WHERE USED	DURATION OF USE (Weeks)	TYPE OF USE
-------------------------------------	--------------------------------------	------------	-------------------------	-------------

[illegible]

## MANUFACTURER OF INSTRUMENT

USE (Monitoring, Surveying, Measuring, etc.)


10. REMARKS (State additional information which will assist Committee in evaluating your qualifications to use radioisotopes or other sources of ionizing radiation, i.e., pertinent publications, patents, speeches, board certifications, etc.)

11. SIGNATURE OF USER

12. DATE



## APPENDIX C

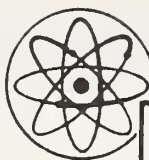
TYPE OR WRITE FIRMLY - NO CARBON NEEDED

U. S. DEPARTMENT OF AGRICULTURE		1. AGENCY
<b>REPORT OF RECEIPT OF RADIOACTIVE MATERIALS</b>		2. DIVISION, BRANCH AND SECTION
<b>INSTRUCTIONS:</b> Immediately upon receipt of shipment perform survey and check contents for kind, quantity and acceptability. Complete form and return original promptly to Radiological Safety Officer, USDA, Plant Industry Station, Beltsville, Maryland 20705.		3. ADDRESS (Include Zip Code)
SECTION A - SHIPMENT		
1. RADIOLOGICAL SAFETY COMM. IDENTIFICATION	2. LICENSE NUMBER	3. PURCHASE ORDER NUMBER
4. DATE RECEIVED	5. ISOTOPE	6. QUANTITY (mc)
7. CHEMICAL FORM	8. SPECIFIC ACTIVITY	
SECTION B - SURVEY		
1. INSTRUMENT USED		
2. CALIBRATION		3. BACKGROUND
CPM	MR/HR	CPS
4. READING FROM PACKAGES BEFORE OPENING (Distance)		5. READING FROM MATERIAL AFTER REMOVAL FROM PACKAGES (Distance)
6. READING FROM STORAGE AREA AFTER ISOTOPE IS STORED (Distance)		7. READING AT NEAREST ROUTINE APPROACH TO STORAGE AREA (Distance)
8. MAXIMUM READING DURING TRANSFER FROM CONTAINER TO STORAGE		
9. TIME REQUIRED FOR TRANSFER		
10. COMMENTS		

RETAIN YELLOW COPY FOR FILES

11. TITLE	12. SIGNATURE	13. DATE
-----------	---------------	----------

## APPENDIX D



UNITED STATES ATOMIC ENERGY COMMISSION  
RULES and REGULATIONS • TITLE 10 - ATOMIC ENERGY

PART  
20

## STANDARDS FOR PROTECTION AGAINST RADIATION

## GENERAL PROVISIONS

- Sec.  
20.1 Purpose.  
20.2 Scope.  
20.3 Definitions.  
20.4 Units of radiation dose.  
20.5 Units of radioactivity.  
20.6 Interpretations.  
20.7 Communications.

## PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

- 20.101 Exposure of individuals to radiation in restricted areas.  
20.102 Determination of accumulated dose.  
20.103 Exposure of individuals to concentrations of radioactive material in restricted areas.  
20.104 Exposure of minors.  
20.105 Permissible levels of radiation in unrestricted areas.  
20.106 Radioactivity in effluents to unrestricted areas.  
20.107 Medical diagnosis and therapy.  
20.108 Orders requiring furnishing of bioassay services.

## PRECAUTIONARY PROCEDURES

- 20.201 Surveys.  
20.202 Personnel monitoring.  
20.203 Caution signs, labels, signals, and controls.  
20.204 Same: exceptions.  
20.205 Procedures for picking up, receiving, and opening packages.  
20.206 Instruction of personnel.  
20.207 Storage of licensed materials.

## WASTE DISPOSAL

- 20.301 General requirement.  
20.302 Method for obtaining approval of proposed disposal procedure.  
20.303 Disposal by release into sanitary sewerage systems.  
20.304 Disposal by burial in soil.  
20.305 Treatment or disposal by incineration.

## RECORDS, REPORTS, AND NOTIFICATION

- 20.401 Records of surveys, radiation monitoring, and disposal.  
20.402 Reports of theft or loss of licensed material.  
20.403 Notifications of incidents.  
20.404 [Reserved]  
20.405 Reports of overexposure and excessive levels and concentrations.  
20.406 [Reserved]  
20.407 Personnel exposure and monitoring reports.  
20.408 Reports of personnel exposure on termination of employment or work.  
20.409 Notifications and reports to individuals.

## EXCEPTIONS AND ADDITIONAL REQUIREMENTS

- 20.501 Applications for exemptions.  
20.502 Additional requirements.

## ENFORCEMENT

- 20.601 Violations.  
Appendix A—[Reserved]  
Appendix B—Concentrations in air and water above natural background.  
Appendix C.  
Appendix D—United States Atomic Energy Commission Regulatory Operations Regional Offices.

## GENERAL PROVISIONS

## § 20.1 Purpose.

(a) The regulations in this part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Atomic Energy Commission and are issued pursuant to the Atomic Energy Act of 1954 (68 Stat. 919).

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this part. However, it is the purpose of the regulations in this part to control the possession, use, and transfer of licensed material by any licensee in such a manner that exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this part.

(c) In accordance with recommendations of the Federal Radiation Council, approved by the President, persons engaged in activities under licenses issued by the Atomic Energy Commission pursuant to the Atomic Energy Act of 1954, as amended, should, in addition to complying with the requirements set forth in this part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in this part as practicable. The term "as far below the limits specified in this part as practicable" means as low as is practicably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest.

## § 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use or transfer byproduct material, source material, or special nuclear material under a general or specific license issued by the Commission pursuant to the regulations in Part 30, 40, or 70 of this chapter.

## § 20.3 Definitions.

(a) As used in this part:

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "Byproduct material" means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

(4) "Calendar quarter" means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter. No licensee shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

(5) "Commission" means the Atomic Energy Commission or its duly authorized representatives;

(6) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government;



## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

(7) "Individual" means any human being;

(8) "Licensed material" means source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter;

(9) "License" means a license issued under the regulations in Part 30, 40, or 70 of this chapter. "Licensee" means the holder of such license;

(10) "Occupational dose" includes exposure of an individual to radiation (i) in a restricted area; or (ii) in the course of employment in which the individual's duties involve exposure to radiation; provided, that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

(11) "Person" means (i) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission, any State, any foreign government or nation or any political subdivision of any such government or nations, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing;

(12) "Radiation" means any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light;

(13) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission;

(14) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area;

(15) "Source material" means (i) uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of a. uranium, b. thorium or c. any combination thereof. Source material does not include special nuclear material.

(16) "Special nuclear material" means (i) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or (ii) any material artificially enriched by any of the foregoing but does not include source material;

(17) "Unrestricted area" means any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

(b) Definitions of certain other words and phrases as used in this part are set forth in other sections, including:

(1) "Airborne radioactivity area" defined in § 20.203;

(2) "Radiation area" and "high radiation area" defined in § 20.202;

(3) "Personnel monitoring equipment" defined in § 20.202;

(4) "Survey" defined in § 20.201;

(5) Units of measurement of dose (rad, rem) defined in § 20.4;

(6) Units of measurement of radioactivity defined in § 20.5.

#### § 20.4 Units of radiation dose.

(a) "Dose," as used in this part, is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When the regulations in this part specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use. Definitions of units as used in this part are set forth in paragraphs (b) and (c) of this section.

(b) The rad, as used in this part, is a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad.)

(c) The rem, as used in this part, is a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (r) of X-rays. (One millirem (mrem) = 0.001 rem.) The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purpose of the regulations in this part, any of the following is considered to be equivalent to a dose of one rem:

(1) A dose of 1 r due to X- or gamma radiation;

(2) A dose of 1 rad due to X-, gamma, or beta radiation;

(3) A dose of 0.1 rad due to neutrons or high energy protons;

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye; If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in subparagraph (3) of this paragraph, one rem of neutron radiation may, for purposes of the regulations in this part, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the

neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm <sup>2</sup> )	Average flux to deliver 100 millirem in 40 hours (neutrons/cm <sup>2</sup> per sec.)
Thermal	970×10 <sup>6</sup>	670
0.001	720×10 <sup>6</sup>	500
0.005	820×10 <sup>6</sup>	570
0.02	400×10 <sup>6</sup>	280
0.1	120×10 <sup>6</sup>	80
0.5	43×10 <sup>6</sup>	30
1.0	26×10 <sup>6</sup>	18
2.5	29×10 <sup>6</sup>	20
5.0	26×10 <sup>6</sup>	18
7.5	24×10 <sup>6</sup>	17
10	24×10 <sup>6</sup>	17
10 to 30	14×10 <sup>6</sup>	10

(d) For determining exposures to X or gamma rays up to 3 Mev, the dose limits specified in §§ 20.101 to 20.104, inclusive, may be assumed to be equivalent to the "air dose". For the purpose of this part "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate.

#### § 20.5 Units of radioactivity.

(a) Radioactivity is commonly, and for purposes of the regulations in this part shall be, measured in terms of disintegrations per unit time or in curies. One curie = 3.7×10<sup>10</sup> disintegrations per second (dps) = 2.2×10<sup>10</sup> disintegrations per minute (dpm). Commonly used submultiples of the curie are the millicurie and the microcurie:

(1) One millicurie (mCi) = 0.001 curie (Ci) = 3.7×10<sup>7</sup> dps.

(2) One microcurie (μCi) = 0.000001 curie = 3.7×10<sup>4</sup> dps.

(b) For purposes of the regulations in this part, it may be assumed that the daughter activity concentrations in the following table are equivalent to an air concentration of 10<sup>-7</sup> microcuries of Radon 222 per milliliter of air in equilibrium with the daughters RaA, RaB, RaC, and RaC'.

Maximum time between collection and measurement (hours) *	Alpha-emitting daughter activity collected per milliliter of air	
	Microcuries/cc	Total alpha disintegrations per minute per cc.
0.5	7.2×10 <sup>-3</sup>	0.16
1	4.5×10 <sup>-3</sup>	0.10
2	1.3×10 <sup>-3</sup>	0.028
3	0.3×10 <sup>-3</sup>	0.0072

\* Wherever possible, the appropriate unit should be written out as "curie(s)," "millicurie(s)," or "microcurie(s)," and the abbreviations should not be used.

\* The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.



## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

» (c) [Deleted 39 FR 23990]

25 FR 10914 § 20.6 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

31 FR 4648 § 20.7 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part, and applications filed under them, should be addressed to the Director of Regulation, U.S. Atomic Energy Commission, Washington, D.C., 20545. Communications, reports and applications may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; at 7920 Norfolk Avenue, Bethesda, Md.; or at Germantown, Md.

PREREQUISITE DOSES, LEVELS, AND CONCENTRATIONS

25 FR 10914 § 20.101 Exposure of individuals to radiation in restricted areas.

(a) Except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in the following table:

Rems per calendar quarter

- |  |     |
|--|-----|
| 1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads..... | 1%  |
| 2. Hands and forearms; feet and ankles.....  | 18% |
| 3. Skin of whole body.....   | 7%  |

(b) A licensee may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the dose to the whole body from radioactive material and other sources of radiation in the licensee's possession shall not exceed 3 rems; and

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed  $\frac{1}{2}$  (N-18) rems where "N" equals the in-

dividual's age in years at his last birthday; and

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form AEC-4, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of § 20.102. As used in paragraph (b), "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

§ 20.102 Determination of accumulated dose.

(a) This section contains requirements which must be satisfied by licensees who propose, pursuant to paragraph (b) of § 20.101, to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101.

(b) Before permitting any individual in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of § 20.101, each licensee shall:

(1) Obtain a certificate on Form AEC-4, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received an occupational dose of radiation; and

(2) Calculate on Form AEC-4 in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under § 20.101(b).

(c) (1) In the preparation of Form AEC-4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of body	Column 1	Column 2
	Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye.	3%	1%

\* Amended 34 FR 19346

\*\* Amended 36 FR 1466

(2) The licensee shall retain and preserve records used in preparing Form AEC-4.

If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961 yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in paragraph (b) of § 20.101, the excess may be disregarded.

§ 20.103 Exposure of individuals to concentrations of radioactive material in restricted areas.

(a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix B, Table I, of this part. "Exposure" as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the Commission pursuant to paragraph (c) of this section.

(b) The limits given in Appendix B, Table I, of this part are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c) (1) Except as authorized by the Commission pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix B, Table I.

(2) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable; and that the individual will not inhale the concentrations in excess of the limits established in Appendix B, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations; and a description of the methods used in determining the particle sizes.

(3) The Commission may authorize a licensee to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix B, Table I, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest or absorb quanti-



## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

ties of radioactive material in excess of those which might otherwise be permitted under this part for employees in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

(i) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(ii) Procedures for the fitting, maintenance and cleaning of the protective equipment; and

(iii) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

(iv) The average concentrations present in the areas occupied by employees.

#### § 20.104 Exposure of minors.

(a) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area who is under 18 years of age, to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of § 20.101.

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual within a restricted area, who is under 18 years of age to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix "B", Table II of this part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

(c) The provisions of paragraph (c) of § 20.103, shall apply to exposures subject to paragraph (b) of this section.

#### § 20.105 Permissible levels of radiation in unrestricted areas.

(a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use or transfer licensed material in such a manner as to create in any unrestricted

area from radioactive material and other sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour; or

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

#### § 20.106 Radioactivity in effluents to unrestricted areas.

(a) A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix "B", Table II of this part, except as authorized pursuant to § 20.302 or paragraph (b) of this section. For purposes of this section concentrations may be averaged over a period not greater than one year.

(b) An application for a license or amendment may include proposed limits higher than those specified in paragraph (a) of this section. The Commission will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual to concentrations of radioactive material in air or water exceeding the limits specified in Appendix "B", Table II of this part.

(c) An application for higher limits pursuant to paragraph (b) of this section shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak concentration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) chemical composition;

(ii) physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents;

(iii) the hydrogen ion concentrations (pH) of liquid effluents; and

(iv) the size range of particulates in effluents released into air.

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of water uses downstream from the point of release of the effluent.

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year:

(i) In air at any point of human occupancy; or

(ii) In water at points of use downstream from the point of release of the effluent.

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent.

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and calculations to determine concentrations of radionuclides in the unrestricted area and possible reconcentrations of radionuclides.

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section the concentration limits in Appendix "B", Table II of this part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the Commission may limit quantities of radioactive materials released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third the concentration of radioactive materials specified in Appendix "B", Table II of this part.

(f) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by § 20.303

#### § 20.107 Medical diagnosis and therapy.

Nothing in the regulations in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or medical therapy.

## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

## § 20.108 Orders requiring furnishing of bio-assay services.

Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Commission may incorporate appropriate provisions in any license, directing the licensee to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Commission.

## PRECAUTIONARY PROCEDURES

## § 20.201 Surveys.

(a) As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee shall make or cause to be made such surveys as may be necessary for him to comply with the regulations in this part.

## § 20.202 Personnel monitoring.

(a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of § 20.101.

(2) Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in paragraph (a) of § 20.101.

(3) Each individual who enters a high radiation area.

(b) As used in this part,

(1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e. g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

(2) "Radiation area" means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirems;

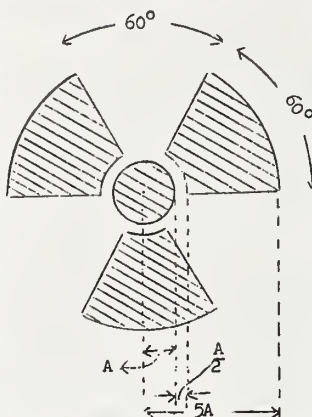
(3) "High radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

## § 20.203 Caution signs, labels, signals, and controls.

(a) General. (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

## RADIATION SYMBOL

1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, licensees may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation or to radioactive material.

(b) Radiation areas. Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION  
RADIATION AREA

(c) High radiation areas. (1) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION  
HIGH RADIATION AREA

(2) Each entrance or access point to a high radiation area shall be:

(i) Equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in 1 hour upon entry into the area; or

(ii) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the licensee or a supervisor of the activity are made aware of the entry; or

(iii) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

(3) The controls required by subparagraph (2) of this paragraph shall be established in such a way that no individual will be prevented from leaving a high radiation area.

(4) In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by subparagraph (2) of this paragraph.

(5) Any licensee, or applicant for a license, may apply to the Commission for approval of methods not included in subparagraphs (2) and (4) of this paragraph for controlling access to high radiation areas. The Commission will approve the proposed alternatives if the licensee or applicant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of subparagraph (3) of this paragraph is met.

(d) Airborne radioactivity areas. (1) As used in the regulations in this part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table I, Column 1 of this part; or (ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table I, Column 1 of this part.

(2) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION  
AIRBORNE RADIOACTIVITY AREA

(e) Additional requirements. (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION  
RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one-hundred times the quantity specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

May 8, 1970

<sup>1</sup> Or "Danger."



## Appendix D—Continued

## PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

**CAUTION:  
RADIOACTIVE MATERIAL(S)**

(f) *Containers.* (1) Except as provided in subparagraph (3) of this paragraph, each container of licensed material shall bear a durable, clearly visible label identifying the radioactive contents.

(2) A label required pursuant to subparagraph (1) of this paragraph shall bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". It shall also provide sufficient information<sup>1</sup> to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of subparagraph (1) of this paragraph, labeling is not required:

(i) For containers that do not contain licensed materials in quantities greater than the applicable quantities listed in Appendix C of this part.

(ii) For containers containing only natural uranium or thorium in quantities no greater than 10 times the applicable quantities listed in Appendix C of this part.

(iii) For containers that do not contain licensed materials in concentrations greater than the applicable concentrations listed in Column 2, Table I, Appendix B of this part.

(iv) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established by the regulations in this part.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations of the Department of Transportation.

(vi) For containers which are accessible only to individuals authorized to handle or use them, or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record.

(vii) For manufacturing or process equipment, such as nuclear reactors, reactor components, piping, and tanks.

<sup>1</sup> As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, mass enrichment, etc.

<sup>2</sup> For example, containers in locations such as water-filled canals, storage vaults, or hot cells.

<sup>3</sup> Amended 34 FR 19546

**§ 20.204 Same: exceptions.**

Notwithstanding the provisions of § 20.203.

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs, and control of entrance or access thereto pursuant to § 20.203(c) is not required, because of the presence of patients containing byproduct material provided that there are personnel in attendance who will take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

(c) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this part and; (2) such area or room is subject to the licensee's control.

(d) A room or other area is not required to be posted with a caution sign, and control is not required for each entrance or access point to a room or other area which is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with regulations of the Department of Transportation.

**§ 20.205 Procedures for picking up, receiving, and opening packages.**

(a) (1) Each licensee who expects to receive a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section shall:

(i) If the package is to be delivered to the licensee's facility by the carrier, make arrangements to receive the package when it is offered for delivery by the carrier; or

(ii) If the package is to be picked up by the licensee at the carrier's terminal, make arrangements to receive notification from the carrier of the arrival of the package, at the time of arrival.

(2) Each licensee who picks up a package of radioactive material from a carrier's terminal shall pick up the package expeditiously upon receipt of notification from the carrier of its arrival.

(b) (1) Each licensee, upon receipt of a package of radioactive material, shall monitor the external surfaces of the package for radioactive contamination caused by leakage of the radioactive contents, except:

(i) Packages containing no more than the exempt quantity specified in the table in this paragraph;

(ii) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125;

(iii) Packages containing only radioactive material as gases or in special form;

(iv) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit specified in the table in this paragraph; and

(v) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

The monitoring shall be performed as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or eighteen hours if received after normal working hours.

(2) If removable radioactive contamination in excess of 0.01 microcuries (22,000 disintegrations per minute) per 100 square centimeters of package surface is found on the external surfaces of the package, the licensee shall immediately notify<sup>1</sup> the final delivering carrier and, by telephone and telegraph, the appropriate Atomic Energy Commission Regulatory Operations Regional Office shown in Appendix D.

TABLE OF EXEMPT AND TYPE A QUANTITIES

Transport group <sup>1</sup>	Exempt quantity (in millicuries)	Type A quantity (in curies)
I.....	.01	0.001
II.....	0.1	0.030
III.....	1	3
IV.....	1	20
V.....	1	100
VI.....	25,000	1000
VII.....	1	20
Special Form.....		

<sup>1</sup> The definitions of "transport group" and "special form" are specified in § 71.4 of this chapter.

(c) (1) Each licensee, upon receipt of a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section, other than those transported by exclusive use vehicle, shall monitor the radiation levels external to the package. The package shall be monitored as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or 18 hours if received after normal working hours.

(2) If radiation levels are found on the external surface of the package in excess of 200 millirem per hour, or at three feet from the external surface of the package in excess of 10 millirem per hour, the licensee shall immediately notify<sup>1</sup> by

<sup>1</sup> The reporting requirements in § 20.205 have been approved by GAO under number B-180 225 (R 0054).

## Appendix D—Continued

## PART 20 -- STANDARDS FOR PROTECTION AGAINST RADIATION

telephone and telegraph, the final delivering carrier and the appropriate Atomic Energy Commission Regulatory Operations Regional Office shown in Appendix D.

(d) Each licensee shall establish and maintain procedures for safely opening packages in which licensed material is received, and shall assure that such procedures are followed and that due consideration is given to special instructions for the type of package being opened.

#### § 20.206 Instruction of personnel.

Instructions required for individuals working in or frequenting any portion of a restricted area are specified in § 19.12 of this chapter.

#### § 20.207 Storage of licensed materials.

Licensed materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

### WASTE DISPOSAL

#### § 20.301 General requirement.

No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70 of this chapter, whichever may be applicable; or

(b) As authorized pursuant to § 20.302; or

(c) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.106 (Radioactivity in Effluents to Unrestricted Areas).

#### § 20.302 Method for obtaining approval of proposed disposal procedures.

\* (a) Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities, and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

\* (b) The Commission will not approve any application for a license to receive licensed material from other persons for disposal on land not owned by the Federal government or by a State government.

(c) The Commission will not approve any application for a license for disposal of licensed material at sea unless the applicant shows that sea disposal offers less harm to man or the environment than other practical alternative methods of disposal.

#### § 20.303 Disposal by release into sanitary sewerage systems.

No licensee shall discharge licensed material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water; and

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table I, Column 2 of this part; or

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table I, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

#### § 20.304 Disposal by burial in soil.

No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

(b) Burial is at a minimum depth of four feet; and

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

#### § 20.305 Treatment or disposal by incineration.

No licensee shall treat or dispose of licensed material by incineration except as specifically approved by the Commission pursuant to §§ 20.106(b) and 20.302.

\*Redesignated 36 FR 23138



## Appendix D—Continued

## PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

## RECORDS, REPORTS, AND NOTIFICATION

## § 20.401 Records of surveys, radiation monitoring, and disposal.

(a) Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under § 20.202 of the regulations in this part. Such records shall be kept on Form AEC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form AEC-5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(b) Each licensee shall maintain records in the same units used in this part, showing the results of surveys required by § 20.201(b), monitoring required by §§ 20.205(b) and 20.205(c), and disposals made under §§ 20.302, 20.303, and 20.304.

(c) Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of paragraph (a) of this section and records of bio-assays, including results of whole body counting examinations, made pursuant to § 20.108 shall be preserved indefinitely or until the Commission authorizes their disposal. Records which must be maintained pursuant to this part may be maintained in the form of microfilms.

## § 20.402 Reports of theft or loss of licensed material.

(a) Each licensee shall report by telephone and telegraph to the Director of the appropriate Atomic Energy Commission Regulatory Operations Regional Office\* listed in Appendix D, immediately after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

(b) Each licensee who is required to make a telephonic and telegraphic report pursuant to paragraph (a) of this section shall, within 30 days after he learns of the loss or theft, make a report in writing to the

Director of Regulatory Operations,\*

U.S. Atomic Energy Commission, Washington, D.C. 20545, with a copy to the Director of the appropriate Atomic Energy Commission

Regulatory Operations Regional Office\* listed in Appendix D, setting forth the following information:

(1) A description of the licensed material involved, including kind, quantity, chemical, and physical form;

(2) A description of the circumstances under which the loss or theft occurred;

(3) A statement of disposition or probable disposition of the licensed material involved;

(4) Radiation exposures to individuals, circumstances under which the exposures occurred, and the extent of possible hazard to persons in unrestricted areas;

(5) Actions which have been taken, or will be taken, to recover the material; and

(6) Procedures or measures which have been or will be adopted to prevent a recurrence of the loss or theft of licensed material.

(c) Subsequent to filing the written report the licensee shall also report any substantive additional information on the loss or theft which becomes available to the licensee, within 30 days after he learns of such information.

(d) Any report filed with the Commission pursuant to this section shall be so prepared that names of individuals who may have received exposure to radiation are stated in a separate part of the report.

## § 20.403 Notifications of incidents.

(a) *Immediate notification.* Each licensee shall immediately notify the Director of the appropriate Atomic Energy Commission

Regulatory Operations Regional Office\* shown in Appendix D by telephone and telegraph of any incident involving by-product, source or special nuclear material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual of 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one working week or more of the operation of any facilities affected; or

(4) Damage to property in excess of \$100,000.

(b) *Twenty-four hour notification.* Each licensee shall within 24 hours notify the Director of the appropriate Atomic Energy Commission

Regulatory Operations Regional Office\* listed in Appendix D

by telephone and telegraph of any incident involving licensed material possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix B, Table II; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of \$1,000.

(c) Any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

## § 20.405 Reports of overexposures and excessive levels and concentrations.

(a) In addition to any notification required by § 20.403, each licensee shall make a report in writing within 30 days to the

Director of Regulatory Operations,\* U.S. Atomic Energy Commission, Washington, D.C., 20545 with

a copy to the Director of the appropriate Atomic Energy Commission

Regulatory Operations Regional Office\* listed in Appendix D,

of (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit in this part or in the licensee's license; (2) any incident for which notification is required by § 20.403; and (3) levels of radiation or concentrations of radioactive material (not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit set forth in this part or in the licensee's license.

Each report required under this paragraph shall describe the extent of exposure of persons to radiation or to radioactive material, including estimates of each individual's exposure as required by paragraph (b) of this section; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence.

\*Section 20.404 was deleted by 38 FR 22220.

\*As amended by 38 FR 1271.

June 1, 1974



## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

(b) Any report filed with the Commission pursuant to this section shall include for each individual exposed the name, social security number, and date of birth; and an estimate of the individual's exposure. The report shall be prepared so that this information is stated in a separate part of the report.

† (c)

† § 20.406

#### § 20.407 Personnel exposure and monitoring reports.

(a) This section applies to each person licensed by the Commission to:

(1) Operate a nuclear reactor designed to produce electrical or heat energy pursuant to § 50.21(b) or § 50.22 of this chapter or a testing facility as defined in § 50.2(r) of this chapter;

(2) Possess or use byproduct material for purposes of radiography pursuant to Parts 30 and 34 of this chapter;

(3) Possess or use at any one time, for purposes of fuel processing fabrication, or reprocessing, special nuclear material in a quantity exceeding 5,000 grams of contained uranium-235, uranium-233, or plutonium or any combination thereof pursuant to Part 70 of this chapter; or

(4) Possess or use at any one time, for processing or manufacturing for distribution pursuant to Part 30, 32, or 33 of this chapter, byproduct material in quantities exceeding any of the following quantities:

Radionuclide <sup>1</sup>	Quantity in curies
Cesium-137	1
Cobalt-60	1
Gold-198	100
Iodine-131	1
Iridium-192	10
Krypton-88	1,000
Promethium-147	10
Technetium-99m	1,000

(b) Each person described in paragraph (a) of this section shall, within the first quarter of each calendar year, submit to the Director of Regulation, U.S. Atomic Energy Commission, Washington, D.C. 20545, the following reports, applicable to the described licensed activities covering the preceding calendar year:<sup>2</sup>

<sup>1</sup> The Commission may require, as a license condition, or by rule, regulation or order pursuant to § 20.502, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

<sup>2</sup> The report for calendar year 1973 shall be submitted by May 6, 1974. A licensee whose license expires or terminates prior to, or on the last day of the calendar year, shall submit reports at the expiration or termination of the license, covering that part of the year during which the licensee was in effect.

† Deleted by 38 FR 22220

(1) A report of either (i) the total number of individuals for whom personnel monitoring was required under §§ 20.202(a) or 34.33(a) of this chapter during the calendar year, or (ii) the total number of individuals for whom personnel monitoring was provided during the calendar year; *Provided*, that such total includes at least the number of individuals required to be reported under paragraph (b) (1) (i) of this section. The report shall indicate whether it is submitted in accordance with paragraph (b) (1) (i) or (ii) of this section.

(2) A statistical summary report of the personnel monitoring information recorded by the licensee for individuals for whom personnel monitoring was either required or provided, as described in § 20.407(b) (1), indicating the number of individuals whose total whole body exposure recorded during the previous calendar year was in each of the following estimated exposure ranges:

Estimated Whole Body Exposure Range (Rems) <sup>a</sup>	Number of Individuals in each range
No measurable exposure	.....
Measurable exposure less than 0.1	.....
0.1 to 0.25	.....
0.25 to 0.5	.....
0.5 to 0.75	.....
0.75 to 1	.....
1 to 2	.....
2 to 3	.....
3 to 4	.....
4 to 5	.....
5 to 6	.....
6 to 7	.....
7 to 8	.....
8 to 9	.....
9 to 10	.....
10 to 11	.....
11 to 12	.....
12+	.....

The low exposure range data are required in order to obtain better information about the exposures actually recorded. This section does not require improved measurements.

#### § 20.408 Reports of personnel exposure on termination of employment or work.

When an individual terminates employment with a licensee subject to § 20.407, or an individual assigned to work in such a licensee's facility, but not employed by the licensee, completes his work assignment in the licensee's facility, the licensee shall furnish \*

to the Director of Regulation, U.S. Atomic Energy Commission, Washington, D.C. 20545, a report of the individual's exposure to radiation and radioactive material, incurred during the period of employment or work assignment in the licensee's facility, contain-

<sup>a</sup> Individual values exactly equal to the values separating Exposure Ranges shall be reported in the higher range.

\* Amended by 38 FR 22220

ing information recorded by the licensee pursuant to §§ 20.401(a) and 20.108. Such report shall be furnished within 30 days after the exposure of the individual has been determined by the licensee or 90 days after the date of termination of employment or work assignment, whichever is earlier.

#### § 20.409 Notifications and reports to individuals.

(a) Requirements for notifications and reports to individuals of exposure to radiation or radioactive material are specified in § 19.13 of this chapter.

(b) When a licensee is required pursuant to §§ 20.405 or 20.408 to report to the Commission any exposure of an individual to radiation or radioactive material, the licensee shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the Commission, and shall comply with the provisions of § 19.13(a) of this chapter.

#### EXCEPTIONS AND ADDITIONAL REQUIREMENTS

##### § 20.501 Applications for exemptions.

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

##### § 20.502 Additional requirements.

The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

#### ENFORCEMENT

##### § 20.601 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act or any rule, regulation, or order issued thereunder, or any term, condition or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

APPENDIX A [Reserved]

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

Concentrations in Air and Water Above Natural Background—Continued (See notes at end of appendix)	Element (atomic number)	Table I	Isotope <sup>1</sup>	Table II	Element (atomic number)	Table I	Isotope <sup>1</sup>	Table II		
Concentrations in Air and Water Above Natural Background (See notes at end of appendix)	Element (atomic number)	Column 1	Air ( $\mu\text{Ci}/\text{mL}$ )	Column 2	Water ( $\mu\text{Ci}/\text{mL}$ )	Column 1	Air ( $\mu\text{Ci}/\text{mL}$ )	Column 2	Water ( $\mu\text{Ci}/\text{mL}$ )	
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									
	Element (atomic number)									

## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

Concentrations in Air and Water Above Natural Background—Continued (See notes at end of appendix)				Concentrations in Air and Water Above Natural Background—Continued (See notes at end of appendix)			
Element (atomic number)	Isotope <sup>1</sup>	Table I		Element (atomic number)	Isotope <sup>1</sup>	Table I	
		Column 1 Air ( $\mu\text{Ci/ml}$ )	Column 2 Water ( $\mu\text{Ci/ml}$ )			Column 1 Air ( $\mu\text{Ci/ml}$ )	Column 2 Water ( $\mu\text{Ci/ml}$ )
Cobalt (27)	Co 57	$3 \times 10^{-4}$	$2 \times 10^{-2}$	Fermium (100)	Fm 254	$7 \times 10^{-4}$	$4 \times 10^{-3}$
	Co 58m	$2 \times 10^{-7}$	$1 \times 10^{-7}$		Fm 255	$6 \times 10^{-4}$	$4 \times 10^{-3}$
	Co 58	$9 \times 10^{-6}$	$6 \times 10^{-7}$		Fm 256	$1 \times 10^{-4}$	$1 \times 10^{-3}$
	Co 60	$8 \times 10^{-7}$	$3 \times 10^{-8}$		F 18	$3 \times 10^{-9}$	$3 \times 10^{-5}$
Copper (29)	Co 60	$5 \times 10^{-8}$	$3 \times 10^{-9}$	Gadolinium (64)	Gd 153	$2 \times 10^{-9}$	$2 \times 10^{-2}$
	Cu 64	$3 \times 10^{-7}$	$1 \times 10^{-3}$		Gd 159	$5 \times 10^{-4}$	$6 \times 10^{-3}$
	Cm 242	$9 \times 10^{-9}$	$1 \times 10^{-3}$		Ga 72	$2 \times 10^{-7}$	$2 \times 10^{-3}$
	Cm 243	$2 \times 10^{-6}$	$6 \times 10^{-4}$		Ge 71	$4 \times 10^{-7}$	$1 \times 10^{-3}$
Curium (96)	Cm 243	$1 \times 10^{-10}$	$7 \times 10^{-4}$	Germanium (32)	Au 196	$2 \times 10^{-7}$	$5 \times 10^{-3}$
	Cm 244	$2 \times 10^{-12}$	$1 \times 10^{-4}$		Au 198	$6 \times 10^{-7}$	$4 \times 10^{-3}$
	Cm 245	$6 \times 10^{-12}$	$3 \times 10^{-12}$		Au 199	$1 \times 10^{-4}$	$1 \times 10^{-3}$
	Cm 246	$1 \times 10^{-10}$	$2 \times 10^{-12}$		Hf 181	$8 \times 10^{-7}$	$4 \times 10^{-3}$
Dysprosium (66)	Cm 247	$5 \times 10^{-12}$	$1 \times 10^{-4}$	Holmium (67)	Ho 166	$4 \times 10^{-4}$	$2 \times 10^{-3}$
	Cm 248	$1 \times 10^{-10}$	$6 \times 10^{-12}$		H3	$2 \times 10^{-7}$	$1 \times 10^{-1}$
	Cm 249	$6 \times 10^{-12}$	$4 \times 10^{-12}$		Indium (49)	$2 \times 10^{-3}$	$4 \times 10^{-3}$
	Dy 165	$1 \times 10^{-3}$	$6 \times 10^{-3}$		In 113m	$7 \times 10^{-4}$	$4 \times 10^{-3}$
Einsteinium (99)	Dy 166	$2 \times 10^{-7}$	$1 \times 10^{-2}$	Iodine (53)	In 114m	$1 \times 10^{-7}$	$5 \times 10^{-4}$
	Ee 253	$8 \times 10^{-10}$	$7 \times 10^{-4}$		In 115m	$2 \times 10^{-4}$	$1 \times 10^{-3}$
	Ee 254m	$6 \times 10^{-10}$	$5 \times 10^{-4}$		In 115	$2 \times 10^{-4}$	$3 \times 10^{-3}$
	Ee 254	$2 \times 10^{-9}$	$4 \times 10^{-4}$		I 125	$5 \times 10^{-9}$	$4 \times 10^{-3}$
Erbium (68)	Ea 255	$1 \times 10^{-10}$	$8 \times 10^{-4}$	Iodine (53)	I 126	$8 \times 10^{-9}$	$6 \times 10^{-3}$
	Er 169	$4 \times 10^{-10}$	$3 \times 10^{-3}$		I 129	$3 \times 10^{-7}$	$3 \times 10^{-3}$
	Er 171	$4 \times 10^{-7}$	$3 \times 10^{-3}$		I 131	$9 \times 10^{-7}$	$2 \times 10^{-3}$
	Eu 152 (T/2 = 9.2 hrs)	$6 \times 10^{-7}$	$2 \times 10^{-3}$		I 132	$3 \times 10^{-7}$	$2 \times 10^{-3}$
Europium (63)	Eu 152	$3 \times 10^{-7}$	$2 \times 10^{-3}$	Lanthanum (57)	La 138	$9 \times 10^{-7}$	$3 \times 10^{-3}$
	Eu 154 (T/2 = 13 yrs)	$2 \times 10^{-8}$	$6 \times 10^{-4}$		La 139	$2 \times 10^{-7}$	$2 \times 10^{-3}$
	Eu 154	$4 \times 10^{-8}$	$6 \times 10^{-4}$		La 140	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Eu 155	$7 \times 10^{-8}$	$6 \times 10^{-4}$		La 141	$2 \times 10^{-7}$	$2 \times 10^{-3}$
*Amended 37 FR 23319				*Amended 38 FR 29314			



## Appendix D—Continued

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		$(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})$			
Iodine (53)	I 134	$3 \times 10^{-6}$	$2 \times 10^{-3}$	$1 \times 10^{-7}$	$6 \times 10^{-4}$
	I 135	$1 \times 10^{-7}$	$7 \times 10^{-4}$	$1 \times 10^{-9}$	$4 \times 10^{-6}$
Iridium (77)	Ir 190	$1 \times 10^{-6}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$7 \times 10^{-4}$
	Ir 192	$4 \times 10^{-7}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
Iron (26)	Ir 194	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$4 \times 10^{-9}$	$4 \times 10^{-5}$
	Fe 55	$3 \times 10^{-6}$	$1 \times 10^{-3}$	$9 \times 10^{-10}$	$4 \times 10^{-5}$
	Fe 59	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$8 \times 10^{-9}$	$3 \times 10^{-5}$
	Kr 85m	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$3 \times 10^{-9}$	$3 \times 10^{-5}$
Krypton (36)	Kr 85	$9 \times 10^{-7}$	$2 \times 10^{-3}$	$3 \times 10^{-9}$	$8 \times 10^{-4}$
	Kr 87	$1 \times 10^{-7}$	$7 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-3}$
	Kr 88	$1 \times 10^{-7}$	$2 \times 10^{-3}$	$5 \times 10^{-9}$	$6 \times 10^{-5}$
	Lo 140	$6 \times 10^{-6}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$5 \times 10^{-5}$
Lanthanum (57)	Sub	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$1 \times 10^{-7}$	
	Sub	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$3 \times 10^{-7}$	
	Sub	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$2 \times 10^{-7}$	
	Sub	$2 \times 10^{-7}$	$5 \times 10^{-4}$	$5 \times 10^{-9}$	
Lead (82)	Pb 203	$7 \times 10^{-4}$	$7 \times 10^{-4}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Pb 210	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$9 \times 10^{-9}$	$4 \times 10^{-4}$
	Pb 212	$2 \times 10^{-6}$	$1 \times 10^{-3}$	$6 \times 10^{-8}$	$4 \times 10^{-4}$
	Pb 214	$1 \times 10^{-6}$	$4 \times 10^{-6}$	$4 \times 10^{-12}$	$1 \times 10^{-7}$
Lutetium (71)	Lu 177	$2 \times 10^{-8}$	$5 \times 10^{-3}$	$8 \times 10^{-12}$	$2 \times 10^{-4}$
	Mn 52	$2 \times 10^{-8}$	$6 \times 10^{-4}$	$6 \times 10^{-10}$	$2 \times 10^{-3}$
	Mn 54	$2 \times 10^{-8}$	$5 \times 10^{-4}$	$7 \times 10^{-10}$	$2 \times 10^{-3}$
	Mn 56	$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
Manganese (25)	Mn 52	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$2 \times 10^{-3}$
	Mn 54	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Mn 56	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$7 \times 10^{-9}$	$3 \times 10^{-3}$
	Mn 58	$1 \times 10^{-7}$	$9 \times 10^{-4}$	$5 \times 10^{-9}$	$3 \times 10^{-3}$
Mercury (80)	Hg 197m	$4 \times 10^{-7}$	$4 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-4}$
	Hg 197	$8 \times 10^{-7}$	$3 \times 10^{-3}$	$3 \times 10^{-9}$	$1 \times 10^{-4}$
	Hg 203	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$2 \times 10^{-4}$
	Hg 205	$7 \times 10^{-7}$	$6 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
Molybdenum (42)	Mo 99	$8 \times 10^{-7}$	$5 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
	Mo 100	$1 \times 10^{-6}$	$9 \times 10^{-3}$	$4 \times 10^{-9}$	$3 \times 10^{-4}$
	Mo 101	$3 \times 10^{-6}$	$1 \times 10^{-2}$	$9 \times 10^{-9}$	$5 \times 10^{-4}$
	Mo 102	$7 \times 10^{-6}$	$5 \times 10^{-2}$	$2 \times 10^{-8}$	$2 \times 10^{-3}$
Neodymium (60)	Nd 144	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$4 \times 10^{-9}$	$1 \times 10^{-4}$
	Nd 146	$7 \times 10^{-7}$	$5 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
	Nd 148	$2 \times 10^{-11}$	$2 \times 10^{-3}$	$7 \times 10^{-12}$	$4 \times 10^{-3}$
	Nd 150	$2 \times 10^{-11}$	$2 \times 10^{-3}$	$1 \times 10^{-11}$	$7 \times 10^{-3}$
Neodymium (60)	Nd 147	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$8 \times 10^{-3}$
	Nd 149	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$8 \times 10^{-9}$	$6 \times 10^{-3}$
	Nd 151	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$8 \times 10^{-9}$	$6 \times 10^{-3}$
	Nd 152	$1 \times 10^{-6}$	$8 \times 10^{-3}$	$5 \times 10^{-8}$	$3 \times 10^{-4}$

\*Amended 37 FR 23319

†Amended 38 FR 29314

\*\*Added 37 FR 23319

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		$(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})(\mu\text{Ci}/\text{mL})$			
Neptunium (93)	Np 237	$4 \times 10^{-12}$	$9 \times 10^{-3}$	$1 \times 10^{-13}$	$3 \times 10^{-6}$
	Np 239	$1 \times 10^{-10}$	$9 \times 10^{-4}$	$1 \times 10^{-12}$	$3 \times 10^{-3}$
Nickel (28)	Ni 59	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
	Ni 63	$5 \times 10^{-7}$	$6 \times 10^{-3}$	$2 \times 10^{-8}$	$2 \times 10^{-3}$
	Ni 65	$8 \times 10^{-8}$	$8 \times 10^{-4}$	$2 \times 10^{-9}$	$3 \times 10^{-3}$
	Ni 66	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$7 \times 10^{-4}$
Niobium (Columbium) (41)	Nb 93m	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Nb 95	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$5 \times 10^{-9}$	$4 \times 10^{-4}$
	Nb 97	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Nb 99	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
Osmium (76)	Os 185	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Os 191m	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Os 191	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Os 193	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
Palladium (46)	Pd 103	$1 \times 10^{-6}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$3 \times 10^{-4}$
	Pd 109	$7 \times 10^{-7}$	$8 \times 10^{-4}$	$3 \times 10^{-8}$	$9 \times 10^{-4}$
	P 32	$6 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-8}$	$7 \times 10^{-3}$
	Pl 191	$7 \times 10^{-8}$	$5 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-3}$
Phosphorus (15)	Pl 193m	$8 \times 10^{-8}$	$4 \times 10^{-4}$	$3 \times 10^{-9}$	$1 \times 10^{-4}$
	Pl 193	$1 \times 10^{-6}$	$3 \times 10^{-3}$	$2 \times 10^{-7}$	$1 \times 10^{-3}$
	Pl 197m	$3 \times 10^{-7}$	$5 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-3}$
	Pl 197	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-3}$
Plutonium (78)	Pu 238	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
	Pu 239	$2 \times 10^{-12}$	$8 \times 10^{-4}$	$1 \times 10^{-13}$	$5 \times 10^{-6}$
	Pu 240	$3 \times 10^{-11}$	$8 \times 10^{-4}$	$1 \times 10^{-12}$	$3 \times 10^{-5}$
	Pu 241	$9 \times 10^{-11}$	$8 \times 10^{-4}$	$3 \times 10^{-12}$	$2 \times 10^{-4}$

\*Amended 37 FR 23319

†Amended 38 FR 29314

\*\*Added 37 FR 23319

PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

## Appendix D—Continued

APPENDIX B Concentrations in Air and Water Above Natural Background—Continued (See notes at end of appendix)									
Element (atomic number)	Isotope <sup>1</sup>	Table I		Isotope <sup>1</sup>	Table II		Isotope <sup>1</sup>	Table I	
		Column 1 Air ( $\mu\text{Ci/ml}$ )	Column 2 Water ( $\mu\text{Ci/ml}$ )		Column 1 Air ( $\mu\text{Ci/ml}$ )	Column 2 Water ( $\mu\text{Ci/ml}$ )		Column 1 Air ( $\mu\text{Ci/ml}$ )	Column 2 Water ( $\mu\text{Ci/ml}$ )
Plutonium (94)	Pu 242	$2 \times 10^{-13}$	$1 \times 10^{-4}$	Pu 242	$6 \times 10^{-14}$	$5 \times 10^{-4}$	Ru 97	$2 \times 10^{-4}$	$1 \times 10^{-2}$
	Pu 243	$4 \times 10^{-11}$	$9 \times 10^{-4}$		$1 \times 10^{-13}$	$3 \times 10^{-4}$		$2 \times 10^{-4}$	$1 \times 10^{-2}$
	Pu 244	$2 \times 10^{-6}$	$1 \times 10^{-2}$		$6 \times 10^{-8}$	$3 \times 10^{-4}$	Ru 103	$5 \times 10^{-7}$	$2 \times 10^{-3}$
		$2 \times 10^{-6}$	$1 \times 10^{-2}$		$8 \times 10^{-8}$	$2 \times 10^{-3}$		$8 \times 10^{-8}$	$2 \times 10^{-3}$
	Pu 210	$3 \times 10^{-12}$	$1 \times 10^{-4}$		$6 \times 10^{-14}$	$4 \times 10^{-4}$	Ru 105	$7 \times 10^{-7}$	$3 \times 10^{-3}$
		$3 \times 10^{-11}$	$3 \times 10^{-4}$		$1 \times 10^{-12}$	$1 \times 10^{-3}$		$5 \times 10^{-7}$	$3 \times 10^{-3}$
		$5 \times 10^{-10}$	$2 \times 10^{-3}$		$2 \times 10^{-11}$	$7 \times 10^{-7}$	Ru 106	$8 \times 10^{-8}$	$4 \times 10^{-4}$
		$2 \times 10^{-10}$	$8 \times 10^{-4}$		$7 \times 10^{-12}$	$3 \times 10^{-3}$		$6 \times 10^{-8}$	$2 \times 10^{-10}$
	K 42	$2 \times 10^{-6}$	$9 \times 10^{-3}$		$7 \times 10^{-4}$	$3 \times 10^{-4}$	Sm 147	$7 \times 10^{-11}$	$2 \times 10^{-12}$
		$1 \times 10^{-7}$	$6 \times 10^{-4}$		$4 \times 10^{-4}$	$2 \times 10^{-3}$		$3 \times 10^{-10}$	$6 \times 10^{-3}$
	Pr 142	$2 \times 10^{-7}$	$9 \times 10^{-4}$		$7 \times 10^{-4}$	$3 \times 10^{-3}$	Sm 151	$6 \times 10^{-8}$	$1 \times 10^{-2}$
		$2 \times 10^{-7}$	$9 \times 10^{-4}$		$5 \times 10^{-4}$	$3 \times 10^{-3}$		$5 \times 10^{-7}$	$2 \times 10^{-3}$
	Pr 143	$3 \times 10^{-7}$	$1 \times 10^{-3}$		$1 \times 10^{-3}$	$5 \times 10^{-3}$	Sm 153	$4 \times 10^{-7}$	$2 \times 10^{-3}$
		$2 \times 10^{-7}$	$1 \times 10^{-3}$		$6 \times 10^{-4}$	$5 \times 10^{-3}$		$2 \times 10^{-7}$	$1 \times 10^{-4}$
	Promethium (61)	$6 \times 10^{-8}$	$6 \times 10^{-3}$		$3 \times 10^{-4}$	$2 \times 10^{-4}$	Sc 46	$2 \times 10^{-7}$	$1 \times 10^{-3}$
	Pm 147	$1 \times 10^{-7}$	$6 \times 10^{-3}$		$3 \times 10^{-4}$	$2 \times 10^{-4}$		$2 \times 10^{-7}$	$1 \times 10^{-3}$
	Pm 149	$3 \times 10^{-7}$	$1 \times 10^{-3}$		$1 \times 10^{-4}$	$4 \times 10^{-3}$	Sc 47	$6 \times 10^{-7}$	$3 \times 10^{-3}$
		$2 \times 10^{-7}$	$7 \times 10^{-3}$		$8 \times 10^{-4}$	$4 \times 10^{-3}$		$3 \times 10^{-7}$	$3 \times 10^{-3}$
	Protactinium (91)	$2 \times 10^{-9}$	$7 \times 10^{-3}$		$6 \times 10^{-11}$	$2 \times 10^{-4}$	Sc 48	$2 \times 10^{-7}$	$8 \times 10^{-4}$
		$8 \times 10^{-10}$	$7 \times 10^{-3}$		$3 \times 10^{-11}$	$2 \times 10^{-4}$		$1 \times 10^{-7}$	$8 \times 10^{-4}$
	Pu 231	$1 \times 10^{-12}$	$3 \times 10^{-3}$		$4 \times 10^{-14}$	$9 \times 10^{-7}$	Se 75	$1 \times 10^{-6}$	$9 \times 10^{-3}$
		$1 \times 10^{-12}$	$8 \times 10^{-4}$		$4 \times 10^{-12}$	$2 \times 10^{-3}$		$1 \times 10^{-6}$	$4 \times 10^{-4}$
	Pu 233	$6 \times 10^{-7}$	$4 \times 10^{-3}$		$2 \times 10^{-4}$	$1 \times 10^{-4}$	Si 31	$6 \times 10^{-4}$	$3 \times 10^{-3}$
		$2 \times 10^{-7}$	$4 \times 10^{-3}$		$6 \times 10^{-4}$	$1 \times 10^{-4}$		$1 \times 10^{-4}$	$2 \times 10^{-7}$
	Ra 223	$2 \times 10^{-9}$	$2 \times 10^{-3}$		$6 \times 10^{-11}$	$7 \times 10^{-7}$	Ag 105	$6 \times 10^{-4}$	$3 \times 10^{-3}$
		$2 \times 10^{-9}$	$2 \times 10^{-3}$		$8 \times 10^{-12}$	$4 \times 10^{-4}$		$2 \times 10^{-7}$	$3 \times 10^{-3}$
	Ra 224	$5 \times 10^{-9}$	$7 \times 10^{-3}$		$2 \times 10^{-10}$	$2 \times 10^{-4}$	Ag 110m	$8 \times 10^{-4}$	$3 \times 10^{-3}$
		$5 \times 10^{-9}$	$7 \times 10^{-3}$		$2 \times 10^{-11}$	$5 \times 10^{-4}$		$2 \times 10^{-7}$	$9 \times 10^{-4}$
	Ra 226	$3 \times 10^{-11}$	$4 \times 10^{-7}$		$3 \times 10^{-12}$	$3 \times 10^{-5}$	Ag 111	$3 \times 10^{-7}$	$1 \times 10^{-3}$
		$7 \times 10^{-11}$	$9 \times 10^{-7}$		$2 \times 10^{-12}$	$3 \times 10^{-5}$		$2 \times 10^{-7}$	$1 \times 10^{-3}$
	Ra 228	$4 \times 10^{-11}$	$7 \times 10^{-4}$		$2 \times 10^{-12}$	$3 \times 10^{-4}$	Na 22	$9 \times 10^{-9}$	$6 \times 10^{-3}$
		$4 \times 10^{-11}$	$7 \times 10^{-4}$		$1 \times 10^{-12}$	$3 \times 10^{-3}$		$9 \times 10^{-9}$	$6 \times 10^{-3}$
	Rn 220	$3 \times 10^{-7}$	$1 \times 10^{-4}$		$1 \times 10^{-4}$	$3 \times 10^{-3}$	Na 24	$1 \times 10^{-6}$	$4 \times 10^{-4}$
		$1 \times 10^{-7}$	$3 \times 10^{-4}$		$9 \times 10^{-4}$	$6 \times 10^{-4}$		$1 \times 10^{-6}$	$4 \times 10^{-4}$
	Rn 222	$3 \times 10^{-4}$	$2 \times 10^{-2}$		$3 \times 10^{-4}$	$6 \times 10^{-4}$	Sr 85m	$4 \times 10^{-3}$	$2 \times 10^{-1}$
		$2 \times 10^{-7}$	$8 \times 10^{-3}$		$5 \times 10^{-4}$	$3 \times 10^{-4}$		$3 \times 10^{-3}$	$2 \times 10^{-1}$
	Re 183	$2 \times 10^{-7}$	$3 \times 10^{-3}$		$2 \times 10^{-4}$	$3 \times 10^{-4}$	Sr 85	$3 \times 10^{-3}$	$2 \times 10^{-1}$
		$2 \times 10^{-7}$	$3 \times 10^{-3}$		$8 \times 10^{-4}$	$5 \times 10^{-3}$		$3 \times 10^{-3}$	$2 \times 10^{-1}$
	Re 186	$2 \times 10^{-7}$	$1 \times 10^{-3}$		$1 \times 10^{-3}$	$3 \times 10^{-3}$	Sr 89	$1 \times 10^{-7}$	$5 \times 10^{-3}$
		$2 \times 10^{-7}$	$1 \times 10^{-3}$		$3 \times 10^{-7}$	$3 \times 10^{-3}$		$4 \times 10^{-7}$	$5 \times 10^{-3}$
	Re 187	$9 \times 10^{-4}$	$7 \times 10^{-3}$		$2 \times 10^{-4}$	$2 \times 10^{-3}$	Sr 90	$4 \times 10^{-8}$	$8 \times 10^{-4}$
		$5 \times 10^{-7}$	$2 \times 10^{-3}$		$2 \times 10^{-4}$	$6 \times 10^{-3}$		$5 \times 10^{-9}$	$2 \times 10^{-10}$
	Re 188	$4 \times 10^{-7}$	$2 \times 10^{-3}$		$1 \times 10^{-4}$	$3 \times 10^{-3}$	Sr 91	$4 \times 10^{-7}$	$2 \times 10^{-3}$
		$2 \times 10^{-7}$	$9 \times 10^{-4}$		$6 \times 10^{-4}$	$3 \times 10^{-3}$		$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Rh 103m	$8 \times 10^{-3}$	$4 \times 10^{-1}$		$3 \times 10^{-4}$	$1 \times 10^{-2}$	Sr 92	$4 \times 10^{-7}$	$2 \times 10^{-3}$
		$6 \times 10^{-3}$	$3 \times 10^{-1}$		$2 \times 10^{-4}$	$1 \times 10^{-4}$		$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Rh 105	$8 \times 10^{-3}$	$4 \times 10^{-3}$		$3 \times 10^{-4}$	$1 \times 10^{-4}$		$3 \times 10^{-7}$	$2 \times 10^{-3}$
		$5 \times 10^{-7}$	$3 \times 10^{-3}$		$1 \times 10^{-4}$	$7 \times 10^{-3}$	S 35	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Rb 86	$3 \times 10^{-7}$	$2 \times 10^{-3}$		$1 \times 10^{-4}$	$7 \times 10^{-3}$		$3 \times 10^{-7}$	$2 \times 10^{-3}$
		$7 \times 10^{-8}$	$7 \times 10^{-4}$		$2 \times 10^{-4}$	$1 \times 10^{-4}$	Ta 182	$4 \times 10^{-8}$	$1 \times 10^{-3}$
	Rb 87	$5 \times 10^{-7}$	$3 \times 10^{-3}$		$2 \times 10^{-4}$	$2 \times 10^{-4}$		$2 \times 10^{-8}$	$7 \times 10^{-10}$
		$7 \times 10^{-8}$	$5 \times 10^{-3}$		$2 \times 10^{-4}$	$2 \times 10^{-4}$			
†Amended 38 FR 29314									

November 5, 1973

## Appendix D—Continued

## APPENDIX 8

Concentrations in Air and Water Above Natural Background—Continued  
(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I			Table II		
		Column 1	Column 2	Water	Column 1	Column 2	Water
		( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )
Technetium (43)	Tc 96m	$8 \times 10^{-5}$	$4 \times 10^{-1}$	$3 \times 10^{-6}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$
	Tc 96	$3 \times 10^{-5}$	$3 \times 10^{-1}$	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$
	Tc 97m	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-8}$	$5 \times 10^{-4}$	$5 \times 10^{-4}$	$5 \times 10^{-4}$
	Tc 97	$2 \times 10^{-7}$	$5 \times 10^{-3}$	$5 \times 10^{-9}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$
	Tc 99m	$1 \times 10^{-5}$	$2 \times 10^{-1}$	$1 \times 10^{-6}$	$8 \times 10^{-4}$	$8 \times 10^{-4}$	$8 \times 10^{-4}$
Tellurium (52)	Tc 99	$4 \times 10^{-5}$	$2 \times 10^{-1}$	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$
	Tc 125m	$2 \times 10^{-6}$	$1 \times 10^{-3}$	$7 \times 10^{-8}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$
	Tc 127m	$1 \times 10^{-7}$	$5 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$
	Tc 127	$4 \times 10^{-8}$	$2 \times 10^{-3}$	$5 \times 10^{-9}$	$5 \times 10^{-5}$	$5 \times 10^{-5}$	$5 \times 10^{-5}$
	Tc 129m	$2 \times 10^{-6}$	$1 \times 10^{-3}$	$3 \times 10^{-8}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$
Terbium (65)	Tc 129	$8 \times 10^{-8}$	$5 \times 10^{-3}$	$3 \times 10^{-9}$	$3 \times 10^{-5}$	$3 \times 10^{-5}$	$3 \times 10^{-5}$
	Tc 131m	$5 \times 10^{-6}$	$2 \times 10^{-2}$	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$8 \times 10^{-4}$	$8 \times 10^{-4}$
	Tc 132	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-8}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$
	Tl 160	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$4 \times 10^{-9}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$
	Tl 200	$3 \times 10^{-6}$	$1 \times 10^{-3}$	$1 \times 10^{-8}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$
Thallium (81)	Tl 201	$1 \times 10^{-6}$	$7 \times 10^{-3}$	$4 \times 10^{-8}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$	$2 \times 10^{-4}$
	Tl 202	$2 \times 10^{-6}$	$9 \times 10^{-3}$	$7 \times 10^{-8}$	$3 \times 10^{-4}$	$3 \times 10^{-4}$	$3 \times 10^{-4}$
	Tl 204	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$
	Th 227	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-8}$	$7 \times 10^{-5}$	$7 \times 10^{-5}$	$7 \times 10^{-5}$
	Th 228	$3 \times 10^{-6}$	$5 \times 10^{-4}$	$9 \times 10^{-10}$	$6 \times 10^{-5}$	$6 \times 10^{-5}$	$6 \times 10^{-5}$
Thorium (90)	Th 230	$2 \times 10^{-12}$	$2 \times 10^{-6}$	$3 \times 10^{-13}$	$7 \times 10^{-6}$	$7 \times 10^{-6}$	$7 \times 10^{-6}$
	Th 231	$1 \times 10^{-11}$	$5 \times 10^{-6}$	$8 \times 10^{-14}$	$2 \times 10^{-6}$	$2 \times 10^{-6}$	$2 \times 10^{-6}$
	Th 232	$1 \times 10^{-6}$	$7 \times 10^{-3}$	$5 \times 10^{-8}$	$3 \times 10^{-4}$	$3 \times 10^{-4}$	$3 \times 10^{-4}$
	Th natural	$3 \times 10^{-11}$	$1 \times 10^{-3}$	$1 \times 10^{-12}$	$2 \times 10^{-6}$	$2 \times 10^{-6}$	$2 \times 10^{-6}$
		$6 \times 10^{-11}$	$6 \times 10^{-4}$	$2 \times 10^{-12}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$

†Amended 38 FR 29314

\*Added 37 FR 23319

\*\*Amended 39 FR 23990

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX 8

Concentrations in Air and Water Above Natural Background—Continued  
(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I			Table II		
		Column 1	Column 2	Water	Column 1	Column 2	Water
		( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )	( $\mu\text{Ci}/\text{mL}$ )
Thorium (90)	Th 234	$6 \times 10^{-8}$	$5 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$
	Th 230	$3 \times 10^{-8}$	$5 \times 10^{-4}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Th 232	$4 \times 10^{-8}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Th 234	$3 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Th 234	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
Thallium (81)	Tl 201	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$4 \times 10^{-9}$	$4 \times 10^{-9}$	$4 \times 10^{-9}$	$4 \times 10^{-9}$
	Tl 202	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Tl 204	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Tl 204	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Tl 204	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
Tin (50)	Sn 113	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Sn 113	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Sn 113	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Sn 113	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	Sn 113	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
Tungsten (74)	W 181	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	W 185	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	W 187	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	W 187	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
	W 187	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
Uranium (92)	U 230	$3 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 232	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 233	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 234	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 235	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
Vanadium (23)	U 236	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 238	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 240	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 240	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	U 240	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
Xenon (54)	U-natural	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$	$1 \times 10^{-11}$
	V 48	$6 \times 10^{-8}$	$8 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$
	Xe 131m	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Xe 133	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$
	Xe 133m	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$
Ytterbium (70)	Yb 175	$7 \times 10^{-7}$	$3 \times 10^{-3}$	$3 \times 10^{-7}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$
	Y 90	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$6 \times 10^{-7}$	$6 \times 10^{-4}$	$6 \times 10^{-4}$	$6 \times 10^{-4}$
	Y 91m	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$6 \times 10^{-7}$	$6 \times 10^{-4}$	$6 \times 10^{-4}$	$6 \times 10^{-4}$
	Y 91	$2 \times 10^{-3}$	$1 \times 10^{-1}$	$8 \times 10^{-7}$	$8 \times 10^{-7}$	$8 \times 10^{-7}$	$8 \times 10^{-7}$
	Y 92	$4 \times 10^{-8}$	$8 \times 10^{-4}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$
Yttrium (39)	Y 93	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Y 93	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Y 93	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Y 93	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$
	Y 93	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$	$2 \times 10^{-3}$



## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

APPENDIX B  
Concentrations in Air and Water Above Natural Background—Continued  
(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1 ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )	Column 1 Air ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )
Zinc (30)	Zn 65	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$4 \times 10^{-7}$	$1 \times 10^{-4}$
	Zn 69m	$6 \times 10^{-4}$	$5 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-4}$
	Zn 69	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-4}$	$7 \times 10^{-3}$
Zirconium (40)	Zr 69	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-4}$	$6 \times 10^{-3}$
	Zr 93	$7 \times 10^{-4}$	$5 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$
	Zr 93	$9 \times 10^{-4}$	$3 \times 10^{-3}$	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Zr 95	$1 \times 10^{-7}$	$2 \times 10^{-3}$	$4 \times 10^{-7}$	$8 \times 10^{-4}$
	Zr 95	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-4}$	$8 \times 10^{-4}$
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.	Zr 97	$1 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-4}$	$6 \times 10^{-3}$
	Zr 97	$3 \times 10^{-7}$	$5 \times 10^{-4}$	$4 \times 10^{-7}$	$6 \times 10^{-3}$
	Zr 97	$1 \times 10^{-7}$	$5 \times 10^{-4}$	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Sub	$1 \times 10^{-4}$		$3 \times 10^{-4}$	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.		$3 \times 10^{-4}$	$9 \times 10^{-3}$	$1 \times 10^{-10}$	$3 \times 10^{-4}$
Any single radionuclide not listed above, which decays by alpha emis- sion or spontaneous fission.		$6 \times 10^{-10}$	$4 \times 10^{-7}$	$2 \times 10^{-14}$	$3 \times 10^{-4}$

SA is the specific activity of the uranium in-  
cluded. The concentration value for Table II is  
0.007 milligrams uranium per cubic meter of  
air. The specific activity for natural uranium  
is  $6.77 \times 10^{-4}$  curies per gram U. The specific  
activity for other mixtures of U-238, U-235  
and U-234, if not known, shall be:  
SA =  $8.6 \times 10^{-7}$  curies/gram U U-depleted  
SA =  $(0.4 + 0.88 E + 0.0084 E^2) 10^{-4}$  U-235  
where E is the percentage by weight of U-235,  
expressed as percent.

\*Corrected 39 FR 25463

1. Soluble (S); Insoluble (I).  
2. "Sub" means "substantially" as used for submergence in  
a considerable infinite cloud of airborne material.  
3. For soluble mixtures of U-238, U-234  
and U-235 in air chemical toxicity may be the  
limiting factor. If the percent by weight (en-  
richment) of U-235 is less than 6, the con-  
centration value for a 40-hour workweek,  
Table I, is 0.2 milligrams uranium per cubic  
meter of air average. For any enrichment  
the product of the average concentration and  
time of exposure shall not exceed 40-hour workweek  
shall not exceed  $8 \times 10^{-4}$  SA  $\mu\text{Ci}/\text{ml}$ , where

## Appendix D—Continued

## PART 20 -- STANDARDS FOR PROTECTION AGAINST RADIATION

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

c. Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )	Column 1 Air ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 257 are not present.....		$9 \times 10^{-4}$		$3 \times 10^{-4}$
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 257 are not present.....		$6 \times 10^{-4}$		$2 \times 10^{-4}$
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present.....		$2 \times 10^{-4}$		$6 \times 10^{-7}$
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present.....		$3 \times 10^{-4}$		$1 \times 10^{-7}$
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present.....	$3 \times 10^{-4}$		$1 \times 10^{-10}$	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present.....	$3 \times 10^{-10}$		$1 \times 10^{-11}$	
If it is known that alpha-emitters and Ac 227 are not present.....	$3 \times 10^{-11}$		$1 \times 10^{-12}$	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Cm 248, Cf 249 and Cf 251 are not present.....	$3 \times 10^{-12}$		$1 \times 10^{-12}$	

## NOTE TO APPENDIX B

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations  $C_A$ ,  $C_B$ , and  $C_C$ , and if the applicable MPC's are  $MPC_A$ ,  $MPC_B$ , and  $MPC_C$  respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \frac{C_C}{MPC_C} \leq 1$$

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1— $1 \times 10^{-10}$   $\mu\text{Ci}/\text{ml}$  gross alpha activity; or  $5 \times 10^{-11}$   $\mu\text{Ci}/\text{ml}$  natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1— $3 \times 10^{-10}$   $\mu\text{Ci}/\text{ml}$  gross alpha activity; or  $2 \times 10^{-10}$   $\mu\text{Ci}/\text{ml}$  natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this Note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture ( $C_A$ ) to the concentration limit for that radionuclide specified in Table II of Appendix B ( $MPC_A$ ) does not exceed  $\frac{1}{10}$ .

(i.e.  $\frac{C_A}{MPC_A} \leq \frac{1}{10}$ ) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed  $\frac{1}{4}$ .

$$(i.e. \frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \dots \leq \frac{1}{4}).$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

- For purposes of Table I, Col. 1— $6 \times 10^{-10}$
- For purposes of Table I, Col. 2— $4 \times 10^{-7}$
- For purposes of Table II, Col. 1— $2 \times 10^{-12}$
- For purposes of Table II, Col. 2— $3 \times 10^{-12}$

## Appendix D—Continued

## PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX C

Material	Microcuries	Material	Microcuries
Americium-241	.01	Osmium-191	100
Antimony-122	100	Osmium-193	100
Antimony-124	10	Palladium-103	100
Antimony-125	10	Palladium-109	100
Arsenic-73	100	Phosphorus-32	10
Arsenic-74	10	Platinum-191	100
Arsenic-76	10	Platinum-193m	100
Arsenic-77	100	Platinum-193	100
Barium-131	10	Platinum-197m	100
* Barium-133	10	Platinum-197	100
Barium-140	10	Plutonium-239	.01
Bismuth-210	1	Polonium-210	0.1
Bromine-82	10	Potassium-42	10
Cadmium-109	10	Praseodymium-142	100
Cadmium-115m	10	Praseodymium-143	100
Cadmium-115	100	Promethium-147	10
Calcium-45	10	Promethium-149	10
Calcium-47	10	Radium-226	.01
Carbon-14	100	Rhenium-165	100
Cerium-141	100	Rhenium-166	100
Cerium-143	100	Rhodium-103m	100
Cerium-144	1	Rhodium-105	100
Cesium-131	1,000	Rubidium-86	10
Cesium-134m	100	Rubidium-87	10
Cesium-134	1	Ruthenium-97	100
Cesium-135	10	Ruthenium-103	10
Cesium-136	10	Ruthenium-105	10
Cesium-137	10	Ruthenium-108	1
Chlorine-36	10	Samarium-151	10
Chlorine-38	10	Samarium-153	100
Chromium-51	1,000	Scandium-46	10
Cobalt-58m	10	Scandium-47	100
Cobalt-58	10	Scandium-48	10
Cobalt-60	1	Selenium-76	10
Copper-64	100	Silicon-31	100
Dysprosium-165	10	Silver-105	10
Dysprosium-168	100	Silver-110m	1
Erbium-169	100	Silver-111	100
Erbium-171	100	Sodium-24	10
Europium-152 9.2 h.	100	Strontium-85	10
Europium-152 13 yr.	1	Strontium-89	1
Europium-154	1	Strontium-90	0.1
Europium-155	10	Strontium-91	10
Fluorine-18	1,000	Strontium-92	10
Gadolinium-153	10	Sulphur-35	100
Gadolinium-159	100	Tantalum-182	10
Gallium-72	10	Technetium-98	10
Germanium-71	100	Technetium-97m	100
Gold-198	100	Technetium-97	100
Gold-199	100	Technetium-99m	100
Hafnium-181	10	Technetium-99	10
Holmium-166	100	Tellurium-125m	10
Hydrogen-3	1,000	Tellurium-127m	10
Indium-113m	100	Tellurium-127	100
Indium-114m	10	Tellurium-129m	10
Indium-115m	100	Tellurium-129	100
Indium-115	10	Tellurium-131m	10
Iodine-125	1	Tellurium-132	10
Iodine-126	1	Terbium-160	10
Iodine-129	0.1	Thallium-200	100
Iodine-131	1	Thallium-201	100
Iodine-132	10	Thallium-202	100
Iodine-133	1	Thallium-204	10
Iodine-134	10	**Thorium (natural)*	100
Iodine-135	10	Thulium-170	10
Iridium-192	100	Thulium-171	10
Iridium-194	100	Tin-113	10
Iron-55	100	Tin-125	10
Iron-59	10	Tungsten-161	10
Krypton-85	100	Tungsten-185	10
Krypton-87	10	Tungsten-187	100
Lanthanum-140	10	**Uranium (natural)*	100
Laetium-177	100	Uranium-233	.01
Manganese-52	10	Uranium-234—Uranium-235	.01
Manganese-54	10	Vanadium-48	10
Manganese-56	10	Xenon-131m	1,000
Mercury-197m	100	Xenon-133	100
Mercury-197	100	Xenon-135	100
Mercury-203	10	Ytterbium-175	100
Molybdenum-99	100	Yttrium-90	10
Neodymium-147	100	Yttrium-91	10
Neodymium-149	100	Yttrium-92	100
Nickel-59	100	Yttrium-93	100
Nickel-63	10	Zinc-65	10
Nickel-65	100	Zinc-69m	100
Niobium-93m	10	Zinc-69	1,000
Niobium-95	10	Zirconium-93	10
Niobium-97	10	Zirconium-95	10
Osmium-185	10	Zirconium-97	10
Osmium-191m	100		

Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition .01

Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition... 1

NOTE: For purposes of §§ 20.203 and 20.304, where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity"). Example: For purposes of § 20.304, if a particular batch contains 20,000  $\mu$ Ci of  $\text{Au}^{198}$  and 50,000  $\mu$ Ci of  $\text{C}^{14}$ , it may also include not more than 300  $\mu$ Ci of  $\text{I}^{131}$ . This limit was determined as follows:

$$\frac{20,000 \mu\text{Ci Au}^{198}}{100,000 \mu\text{Ci}} + \frac{50,000 \mu\text{Ci C}^{14}}{100,000 \mu\text{Ci}} + \frac{300 \mu\text{Ci I}^{131}}{1,000 \mu\text{Ci}} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in § 20.304.

\*Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

\*\*Based on alpha disintegration rate of U-238, U-234, and U-235.

\*Amended 36 FR 16898

\*\*Amended 39 FR 23990

†Amended 38 FR 29314



## Appendix D—Continued

## PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

Appendix D  
UNITED STATES ATOMIC ENERGY COMMISSION  
REGULATORY OPERATIONS REGIONAL OFFICES†

Region	Address	Telephone	
		Daytime	Nights and holidays
I			
Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	Region I, Directorate of Regulatory Operations, USAEC, 631 Park Avenue, King of Prussia, Pennsylvania 19406.	215-337-1150	215-337-1150
II*			
Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Panama Canal Zone, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia	Region II, Directorate of Regulatory Operations, USAEC, Suite 818, 230 Peachtree St., NW., Atlanta, Ga. 30303.	404-526-4503	404-526-4503
III			
Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin	Region III, Directorate of Regulatory Operations, USAEC, 799 Roosevelt Road, Glen Ellyn, Ill. 60137.	312-858-2660	*312-739-7711
IV*			
Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming	*Region IV, Directorate of Regulatory Operations, USAEC, P.O. Box 5039, White Settlement, Texas, 76108	*817-334-2841	*817-334-2841
V			
Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U. S. territories and possessions in the Pacific	Region V, Directorate of Regulatory Operations, USAEC, 1990 N. California Blvd., Suite 202, Walnut Creek, California 94596 *	**415-486-3141	415-273-4237

38 FR 17198

Note: The reporting and recordkeeping requirements contained in 20.205(b) and 20.205(c) and required by 20.401(b) have been approved by GAO under 8-180225 (R0054). The approval expires June 30, 1977.

\* Amended.

\*\* Amended 39 FR 17972.

† Amended 38 FR 1271.

## APPENDIX E

TYPE OR WRITE FIRMLY - NO CARBON NEEDED

U. S. DEPARTMENT OF AGRICULTURE		1. AGENCY
<b>RADIOACTIVE WASTE DISPOSAL REPORT</b>		
<b>INSTRUCTIONS:</b> Record partial disposals as radiomaterial is used and/or disposed of. When <b>ALL</b> material received under purchase order has been disposed of, send original to Radiological Safety Officer, USDA, Plant Industry Station, Beltsville, Maryland 20705.		2. DIVISION, BRANCH AND SECTION
		3. ADDRESS (Include Zip Code)
4. RADIOLOGICAL SAFETY COMM. IDENTIFICATION	5. LICENSE NUMBER	6. PURCHASE ORDER NUMBER
7. ELEMENT AND ISOTOPE		
8. QUANTITY AND FORM (Show original quantity applied, or total used - list all forms of waste)		
9. OBSERVED RADIATION LEVEL OF WASTE-MAXIMUM (Indicate container type and distance)		
10. SITE OF EXPERIMENT		
11. DATE INITIATED	12. DATE TERMINATED	
13. DISPOSAL METHOD (Show concentration in water to sewerage system in microcuries per milliliter.)		
14. DISPOSAL SITE		

RETAIN YELLOW COPY FOR FILES

15. TITLE	16. SIGNATURE	17. DATE
OA Form 3 DEC 1971		
PREVIOUS EDITION OBSOLETE		
USDA - ARS		

## APPENDIX F

U.S. DEPARTMENT OF AGRICULTURE RADIATION SURVEY REPORT				REPORTING PERIOD		
<p><b>NOTICE:</b> Federal Regulations and Department Policy require surveys of laboratories and equipment where ionizing radiation may be a potential hazard. An acceptable survey must be performed at least once every three (3) months. (See RSCM No.13 for procedures and instructions.)</p> <p>1. Complete all applicable items.            2. Report must be signed by a responsible user.            3. Submit reports promptly after the 1st of April, July, October, and January covering the preceding three (3) month period.            4. Mail completed form to USDA Radiological Safety Staff, BARC-West, Beltsville, Maryland 20705.</p> <p>Forms are available from Radiological Safety Staff only.</p>						
NAME & ADDRESS OF STATION OF RESPONSIBLE USER		NAME, TITLE, & ADDRESS OF PERSON PERFORMING SURVEY				
<b>SECTION I - RADIOISOTOPE LABORATORY SURVEY RESULTS</b>						
ROOM OR AREA A	ISOTOPE(S) USED B	WORK SURFACES & FLOORS C	HOODS D	SINKS E	STORAGE AREA F	POSTING & LABELING G
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
<b>SECTION I-A - Make &amp; Model No. of Instrument(s) Used to Perform Survey</b>						



## Appendix F—Continued

SECTION II — RADIATION EQUIPMENT SURVEY RESULTS					
EQUIPMENT IDENTIFICATION A	MAXIMUM READING ON SURFACE OF DEVICE B	MAXIMUM READING AT 3 FT. C	MAXIMUM READING AT CLOSEST APPROACH D	INTERLOCKS, PROTECTIVE SHIELDING, ETC. E	POSTING & LABELING F
1.					
2.					
3.					
4.					
5.					
SECTION II-A — Make & Model No. of Instrument(s) Used to Perform Survey					

## SECTION III — COMMENTS &amp; CORRECTIVE ACTION TAKEN

SIGNATURE OF RESPONSIBLE USER

DATE

OA FORM 41 (3/75) REVERSE

## APPENDIX G

### Code of Federal Regulations

#### Section 311.41<sup>1</sup>—Meat From Animals Which Have Been Exposed to Radiation; Disposition

“Meat from animals to which radioactive material has been administered for research, experimental or veterinary purposes shall be condemned if any radioactive material retained in the meat has not decayed to the normal radiation background level. Meat from animals to which radioactive material has been administered for research, experimental or veterinary purposes will not be considered unwholesome because of this fact if the animals are otherwise sound and if the radioactive material is not retained in the exposed animal or the radioactivity has decayed to the normal radiation background level. For purpose of this section the normal radiation background level shall mean the radiation background of similar samples of meat from animals to which radioactive material has not been administered when measured in the same manner as the meat from the animal to which radioactive material has been administered.”

---

<sup>1</sup> Copied from Code of Federal Regulations—Title 9, Chapter III, Animal and Animal Products (Rev. as of January 1, 1968.)

## APPENDIX H

U. S. DEPARTMENT OF AGRICULTURE		1. OATE REPORT SUBMITTED TO RSS						
SEALED SOURCE LEAK TEST REPORT		2. NAME AND ADDRESS OF STATION OF RESPONSIBLE USER						
<p><b>NOTICE:</b> An acceptable leak test must be performed on appropriate sealed sources of radioactivity immediately upon receipt and subsequently at intervals not to exceed six months. Complete all applicable items. Report must be signed by the responsible user. Submit report within one (1) week after the test to: Radiological Safety Officer, USDA, BARC—West, Beltsville, Maryland 20705. Additional forms are available from the Radiological Safety Staff only.</p>		INSTRUMENTS USED TO PERFORM TEST						
		4. MAKE	5. MODEL NUMBER					
3. NAME, TITLE, AND ADDRESS OF PERSON PERFORMING TEST		SOURCE A	SOURCE B	SOURCE C	SOURCE D	SOURCE E	SOURCE F	SOURCE G
6. Committee Identification No.								
7. Amount of Removable Contamination in MICROCURIES								
8. Serial No. and/or Model No. of Source								
9. Name of Source Manufacturer								
10. Serial No. and/or Model No. of Device								
11. Name of Device Manufacturer								
12. Radioelement in Source								
13. Quantity of Activity in Source in Millicuries								
14. Date Leak Test Performed								
15. ACTION TAKEN WHEN EXCESSIVE CONTAMINATION FOUND (Continue on reverse if necessary)		16. SIGNATURE OF RESPONSIBLE USER						



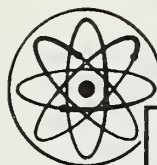


## APPENDIX J—SELECTED BIBLIOGRAPHY

- Radioisotope Techniques, R.T. Overman and H.M. Clark, McGraw-Hill Book Co., Inc., N.Y., 1960.  
 Introduction to Radiological Health, H. Blatz, McGraw-Hill Book Co., Inc., N.Y., 1964.  
 Radiation Protection, J. Shapiro, Harvard University Press, Cambridge, Mass., 1972.  
 Handbook of Laboratory Safety, N.V. Steere, ed., The Chemical Rubber Co., Cleveland, Ohio, 1967.  
 Principles of Radiation Protection, K.Z. Morgan and J.E. Turner, eds., Krieger Publishing Co., N.Y., 1973.  
 Nuclear Radiation Detection, W.J. Price, McGraw-Hill Book Co., Inc., N.Y., 1964.  
 Radiological Health Handbook, compiled and edited by the Bureau of Radiological Health and the Training Institute, Environmental Control Administration, Washington, D.C., 1970, Government Printing Office.  
 Radioactive Tracer Methodology in Biological Science, C.H. Wang and D.I. Willis, Prentice Hall Publishing Co., N.Y., 1965.  
 Radiation Hygiene Handbook, H. Blatz, ed., McGraw-Hill Book Company, Inc., N.Y., 1959.  
 Radiation Injury in Man, E. P. Cronkite and V.P. Bond, Thomas Publishing Co., N.Y., 1960.  
 Source Book on Atomic Energy, S. Glasstone, D Van Nostrand Co., Inc., N.Y., 1967.  
 Atomic Radiation: Theory, Biological Hazards, Safety Measures, Treatment of Injury, RCA Service Co., Government Services, Cherry Hill, N.J., 1967.  
 Nuclear Radiation Physics, R.E. Lapp and H.L. Andrews, Prentice Hall, Inc., N.J., 1974.  
 Radiation Protection Standards, L.S. Taylor, C.R.C. Press, Cleveland, Ohio, 1971.  
 Radiation Protection Measurement, H. Kiefer and R. Maushart, Pergamon Press, N.Y., 1972.  
 An Introduction to Radiation Protection, A. Martin and S.A. Harbison, Chapman Hall, London, 1972.  
 The National Council on Radiation Protection and Measurements (NCRP), P.O. Box 30175, Bethesda, Md. 20014, makes available at nominal cost the following reports on matters of radiation protection and measurement.

<i>Number</i>	<i>Title</i>	
39	Basic Radiation Protection Criteria	1971
38	Protection Against Neutron Radiation	1971
30	Safe Handling of Radioactive Material	1964
10	Radiological Monitoring Methods and Instruments	1952
8	Control and Removal of Radioactive Contamination in Laboratories	1951

## APPENDIX K



UNITED STATES ATOMIC ENERGY COMMISSION

RULES and REGULATIONS • TITLE 10 - ATOMIC ENERGY

# PART 19

NOTICES, INSTRUCTIONS AND REPORTS TO  
WORKERS; INSPECTIONS\*

- Sec.  
19.1 Purpose.  
19.2 Scope.  
19.3 Definitions.  
19.4 Interpretations.  
19.5 Communications.  
19.11 Posting of notices to workers.  
19.12 Instructions to workers.  
19.13 Notifications and reports to individuals.  
19.14 Presence of representatives of licensees and workers during inspections.  
19.15 Consultation with workers during inspections.  
19.16 Requests by workers for inspections.  
19.17 Inspection not warranted; informal review.  
19.30 Violations.  
19.31 Application for exemptions.

AUTHORITY: Atomic Energy Act of 1954; as amended, and sections 552, 553 of title 5, U.S.C.

## § 19.1 Purpose.

The regulations in this part establish requirements for notices, instructions and reports by licensees to individuals participating in licensed activities, and options available to such individuals in connection with Commission inspections of licensees to ascertain compliance with the provisions of the Atomic Energy Act of 1954, as amended, and regulations, orders and licensees issued thereunder regarding radiological working conditions.

## § 19.2 Scope.

The regulations in this part apply to all persons who receive, possess, use or transfer material licensed by the Commission pursuant to the regulations in Parts 30 through 35, 40, or 70 of this chapter, including persons licensed or authorized to operate a production or utilization facility pursuant to Part 50 or Part 115 of this chapter.

## § 19.3 Definitions.

As used in this part:

- (a) "Act" means the Atomic Energy Act of 1954, (68 Stat. 919) including any amendments thereto;  
(b) "Commission" means the United States Atomic Energy Commission;  
(c) "Worker" means an individual engaged in activities licensed by the Commission and controlled by a licensee, but does not include the licensee.  
(d) "License" means a license issued under the regulations in Parts 30 through 35, 40, or 70 of this chapter, including

licenses to operate a production or utilization facility pursuant to Part 50 of this chapter. "Licensee" means the holder of such a license.

(e) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

## § 19.4 Interpretations.

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

## § 19.5 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Director of Regulatory Operations, U.S. Atomic Energy Commission, Washington, D.C. 20545. Communications, reports and applications may be delivered in person at the Commission's offices at 1717 H Street, NW., Washington, D.C.; at 7920 Norfolk Avenue, Bethesda, Maryland; or at Germantown, Maryland.

## § 19.11 Posting of notices to workers.

(a) Each licensee shall post current copies of the following documents: (1) The regulations in this part and in Part 20 of this chapter; (2) the license, license conditions, or documents incorporated into a license by reference, and amendments thereto; (3) the operating procedures applicable to licensed activities; (4) any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or order issued pursuant to Subpart B of Part 2 of this chapter, and any response from the licensee.

(b) If posting of a document specified in paragraph (a) (1), (2) or (3) of this section is not practicable, the licensee may post a notice which describes the document and states where it may be examined.

(c) Form AEC-3, "Notice to Employees," shall be posted by each licensee wherever individuals work in or frequent any portion of a restricted area.

NOTE: Copies of Form AEC-3 may be obtained by writing to the Director of the appropriate U. S. Atomic Energy Commission

Regional Regulatory Operations Office listed in Appendix "D", Part 20 of this chapter, or the Directorate of Licensing, U. S. Atomic Energy Commission, Washington, D.C. 20545.

(d) Documents, notices, or forms posted pursuant to this section shall appear in a sufficient number of places to permit individuals engaged in licensed activities to observe them on the way to or from any particular licensed activity location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.

(e) Commission documents posted pursuant to paragraph (a) (4) of this section shall be posted within 2 working days after receipt of the documents from the Commission; the licensee's response, if any, shall be posted within 2 working days after dispatch by the licensee. Such documents shall remain posted for a minimum of 5 working days or until action correcting the violation has been completed, whichever is later.

## § 19.12 Instructions to workers.

All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Commission regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas; shall be instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of Commission regulations and licenses or unnecessary exposure to radiation or to radioactive material; shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to, radiation or radioactive material; and shall be advised as to the radiation exposure reports which workers may request pursuant to § 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

\*Part 19 was published in 38 FR 22217, Aug. 17, 1973, and became effective Sept. 17, 1973.



## Appendix K—Continued

## PART 19—NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

**§ 19.13 Notifications and reports to individuals.**

(a) Radiation exposure data for an individual, and the results of any measurements, analyses, and calculations of radioactive material deposited or retained in the body of an individual, shall be reported to the individual as specified in this section. The information reported shall include data and results obtained pursuant to Commission regulations, orders or license conditions, as shown in records maintained by the licensee pursuant to Commission regulations. Each notification and report shall: be in writing; include appropriate identifying data such as the name of the licensee, the name of the individual, the individual's social security number; include the individual's exposure information; and contain the following statement:

This report is furnished to you under the provisions of the Atomic Energy Commission regulation 10 CFR Part 19. You should preserve this report for further reference.

(b) At the request of any worker, each licensee shall advise such worker annually of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee pursuant to § 20.401(a) and (c).

(c) At the request of a worker formerly engaged in licensed activities controlled by the licensee, each licensee shall furnish to the worker a report of the worker's exposure to radiation or radioactive material. Such report shall be furnished within 30 days from the time the request is made, or within 30 days after the exposure of the individual has been determined by the licensee, whichever is later; shall cover, within the period of time specified in the request, each calendar quarter in which the worker's activities involved exposure to radiation from radioactive materials licensed by the Commission; and shall include the dates and locations of licensed activities in which the worker participated during this period.

(d) When a licensee is required pursuant to § 20.405 or § 20.408 of this chapter to report to the Commission any exposure of an individual to radiation or radioactive material the licensee shall also provide the individual a report on his exposure data included therein. Such report shall be transmitted at a time not later than the transmittal to the Commission.

**§ 19.14 Presence of representatives of licensees and workers during inspections.**

(a) Each licensee shall afford to the Commission at all reasonable times opportunity to inspect materials, activities, facilities, premises, and records pursuant to the regulations in this chapter.

(b) During an inspection, Commission inspectors may consult privately with workers as specified in § 19.15. The licensee or licensee's representative may accompany Commission inspectors during other phases of an inspection.

(c) If, at the time of inspection, an individual has been authorized by the workers to represent them during Commission inspections, the licensee shall

notify the inspectors of such authorization and shall give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

(d) Each workers' representative shall be routinely engaged in licensed activities under control of the licensee and shall have received instructions as specified in § 19.12.

(e) Different representatives of licensees and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection. However, only one workers' representative at a time may accompany the inspectors.

(f) With the approval of the licensee and the workers' representative an individual who is not routinely engaged in licensed activities under control of the licensee, for example, a consultant to the licensee or to the workers' representative, shall be afforded the opportunity to accompany Commission inspectors during the inspection of physical working conditions.

(g) Notwithstanding the other provisions of this section, Commission inspectors are authorized to refuse to permit accompaniment by any individual who deliberately interferes with a fair and orderly inspection. With regard to areas containing information classified by an agency of the U.S. Government in the interest of national security, an individual who accompanies an inspector may have access to such information only if authorized to do so. With regard to any area containing proprietary information, the workers' representative for that area shall be an individual previously authorized by the licensee to enter that area.

**§ 19.15 Consultation with workers during inspections.**

(a) Commission inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to applicable provisions of Commission regulations and licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.

(b) During the course of an inspection any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which he has reason to believe may have contributed to or caused any violation of the act, the regulations in this chapter, or license condition, or any unnecessary exposure of an individual to radiation from licensed radioactive material under the licensee's control. Any such notice in writing shall comply with the requirements of § 19.16(a).

(c) The provisions of paragraph (b) of this section shall not be interpreted as authorization to disregard instructions pursuant to § 19.12.

**§ 19.16 Requests by workers for inspections.**

(a) Any worker or representative of workers who believes that a violation of the Act, the regulations in this chapter, or license conditions exists or has occurred in license activities with regard to radiological working conditions in which

the worker is engaged, may request an inspection by giving notice of the alleged violation to the Director of Regulatory Operations, to the Director of the appropriate Commission Regional Office, or to Commission inspectors. Any such notice shall be in writing, shall set forth the specific grounds for the notice, and shall be signed by the worker or representative of workers. A copy shall be provided the licensee by the Director of Regulatory Operations, Regional Office Director, or the inspector no later than at the time of inspection except that, upon the request of the worker giving such notice, his name and the name of individuals referred to therein shall not appear in such copy or on any record published, released, or made available by the Commission, except for good cause shown.

(b) If, upon receipt of such notice, the Director of Regulatory Operations or Regional Office Director determines that the complaint meets the requirements set forth in paragraph (a) of this section, and that there are reasonable grounds to believe that the alleged violation exists or has occurred, he shall cause an inspection to be made as soon as practicable, to determine if such alleged violation exists or has occurred. Inspections pursuant to this section need not be limited to matters referred to in the complaint.

(c) No licensee shall discharge or in any manner discriminate against any worker because such worker has filed any complaint or instituted or caused to be instituted any proceeding under the regulations in this chapter or has testified or is about to testify in any such proceeding or because of the exercise by such worker on behalf of himself or others of any option afforded by this part.

**§ 19.17 Inspections not warranted; informal review.**

(a) If the Director of Regulatory Operations or of the appropriate Regional Office determines, with respect to a complaint under § 19.16, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, he shall notify the complainant in writing of such determination. The complainant may obtain review of such determination by submitting a written statement of position with the Director of Regulation, U.S. Atomic Energy Commission, Washington, D.C. 20545, who will provide the licensee with a copy of such statement by certified mail, excluding, at the request of the complainant, the name of the complainant. The licensee may submit an opposing written statement of position with the Director of Regulation who will provide the complainant with a copy of such statement by certified mail. Upon the request of the complainant, the Director of Regulation or his designee may hold an informal conference in which the complainant and the licensee may orally present their views. An informal conference may also be held at the request of the licensee, but disclosure of the identity of the complainant will be made only following receipt of written authorization from the complainant. After considering all written and oral views presented, the Director of Regulation shall

## Appendix K—Continued

## PART 19—NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

affirm, modify, or reverse the determination of the Director of Regulatory Operations or of the appropriate Regional Office and furnish the complainant and the licensee a written notification of his decision and the reason therefor.

(b) If the Director of Regulatory Operations or of the appropriate Regional Office determines that an inspection is not warranted because the requirements of § 19.16(a) have not been met, he shall notify the complainant in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirements of § 19.16(a).

**§ 19.30 Violations.**

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act or any rule, regulation, or order issued thereunder, or any term, condition or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

**§ 19.31 Application for exemptions.**

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

## NOTES



## NOTES

## NOTES





